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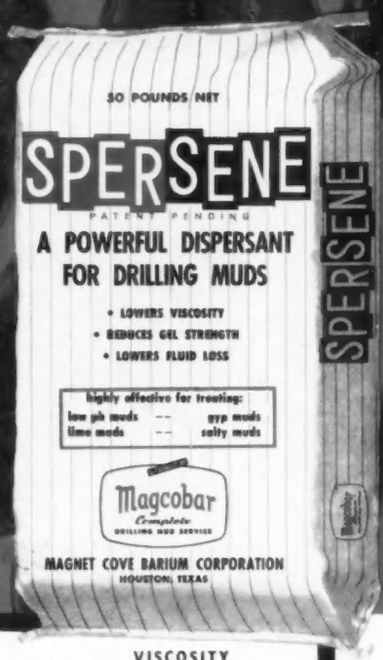

	Amount (pounds)	MATERIALS	Average Cost (Cents)	VISCOSITY (Yield Point-lb./100 ft.^{2})
gyp muds	1	Spersene	16.5	7
	1	Thinner A	18.5	14
lime muds	3.0	Spersene	49.5	6
	3.0	Thinner A	65.5	16
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1959 WORLD OIL

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a Quick Look at this issue . . .

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first

☐ **Shell develops unique data recorder for automatic well testing . . .** Shell Oil Company has installed a machine-sensible analog data recorder in the Bayou Sorrel field, Louisiana, to record well test data. The system permits more thorough analysis of well producing characteristics—and provides a permanent record of each test, enabling the operator to "recreate" any particular test at a later date. For complete details on this unusual installation, turn to . . . . . **Page 79**

☐ **New discoveries spur interest in Wyoming's Green River Basin . . .** Here is a detailed report on one of the most promising gas areas in the Rocky Mountain region—Wyoming's Green River Basin. One-third of the rigs now working in Wyoming are concentrated in this area. For the full story on an area that holds great promise for independent operators, including descriptions of the Basin's hottest areas, a typical drilling program and reasons why activity is expected to remain heavy for at least five years, turn to . . . . . **Page 85**

☐ **Rank wildcats open new area in Kansas-Nebraska . . .** Three oil producers about 18 miles apart are opening a new area in northwestern Kansas and southwestern Nebraska which may well result in one of the most active drilling campaigns in recent years west of the Central Kansas uplift. For a timely report on this promising area, including a description of the new producers, turn to . . . . . **Page 88**

☐ **New technique decreases deflection drilling costs . . .** In these days of increasing overhead and reduced profit margins, contractors and operators are looking hard at new cost-cutting methods. Jet deflection is one of these methods. For an excellent comparison of jet deflection operation and cost with the whipstock method, turn to . . . . . **Page 89**

☐ **Down-hole plastic pipe installations draw interest . . .** Reinforced plastic tubing has been applied successfully to both surface and down-hole installations as a means of reducing corrosion. Here is information on the design considerations necessary to equip salt water disposal wells with plastic pipe. Pumping wells and water supply wells equipped with reinforced plastic pipe also are discussed on . . . . . **Page 91**

☐ **Microbes locate gas production in field test . . .** A field survey in Louisiana indicates that microbes which oxidize light hydrocarbons in soils may be used to find oil and gas directly. This valuable new exploration tool, discussed previously in theoretical terms only, may be particularly effective in combination with seismograph, subsurface and other more conventional exploration methods . . . . . **Page 93**

☐ **What are the prospects in Washington State? . . .** Discovery of oil on the Ocean City anticline in Grays Harbor County on Washington's Pacific Coast has proved that igneous activity, so heavily documented by the State's geology, has not condemned its oil prospects. Thousands of feet of marine Tertiary sediments, including Eocene, Oligocene, Miocene, and Pliocene strata, are prospective in extreme western Washington. Completion problems have been very difficult, but may be overcome in the future with profitable results. Turn to . . . . . **Page 94**

☐ **Are your tool joints being properly applied? . . .** Operators are using two methods to remove tool joints: cutting with an acetylene torch and heating with a dual purpose furnace. The latter method is used when the tool joint is to be salvaged. For a detailed discussion of the advantages and disadvantages of these two methods, turn to . . . . . **Page 99**

☐ **How external casing corrosion is being controlled in East Texas . . .** East Texas field operators have found cathodic protection to be the most economical approach to control of external casing corrosion. To date, 332 rectifiers have been installed for the protection of 459 wells. These installations have so far been 50-100 percent effective when maintained. For a highly informative discussion of the method East Texas operators are using to solve their corrosion problems, see . . . . . **Page 101**

☐ **Industry purchases are up—Supplier's profits are down . . .** Suppliers of oil country materials are facing a frustrating dilemma: Drillers and producers are expected to purchase 5-10 percent more tubular and non-tubular goods during 1959, but supply company profits have yet to reflect the business upturn. For the exclusive story behind this paradoxical situation, turn to . . . . . **Page 106**

☐ **How to plan a directional well . . .** When planning a directional drilling program, it is necessary to thoroughly understand the fundamental terminology and calculations. For a highly informative discussion of the importance of knowing these basic concepts, plus ways in which they can be adapted to directional drilling operations, turn to . . . . . **Page 107**

☐ **Independents do much of the drilling in all areas . . .** Independent operators and smaller companies drill a majority of the wells in all but a few states and districts of the United States. They drill almost 80 percent of all U.S. wells, and from 75 to 100 percent of the wells in all but a few districts. In 1958, they drilled about 38,500 wells, or nearly 80 percent of the U.S. total of 48,341. Meanwhile, 22 large companies drilled about 9,800 wells, or slightly over 20 percent of the total. See . . . . . Page 110

☐ **Puget Sound area has several prospective oil and gas basins . . .** The Green River District near Puget Sound in northwest Washington State has large structures that are favorably comparable to known productive areas in California. Several sedimentary basins occur in the area, and contain large thicknesses of Upper Cretaceous and Tertiary rocks, both marine and non-marine. See . . . . . Page 111

☐ **Know your mud pump (Part II) . . .** Laboratory and field testing of new products is proving a must for several manufacturers of oil field products. This procedure is resulting in more reliable tests, elimination of some designs and better control during testing operations. See . . . . . Page 114

☐ **Non-commercial discovery may forecast oil in Papua . . .** Commercial oil production is a definite prospect for the Australian territory of Papua, north of the main land. A flow of oil at the rate of 1,000 barrels daily was obtained in the discovery well, Puri 1, of Australasian Petroleum Company, Pty. Ltd. The oil came from a limestone zone at 7,460-7,508 feet. It was accompanied by considerable gas and increasing amounts of water. . . . . . Page 118

☐ **Why the oil industry needs a depletion provision . . .** Three leading oil industry organizations have combined their efforts to provide a timely, authoritative report on the rapidly increasing costs and risks involved in developing U.S. oil and gas reserves. It is a report that should be read, not only by the public, but by every government leader attempting to reduce the 27.5 percent depletion provision. Salient facts and figures from the report are presented on. . . . . . Page 120

☐ **Geophysical parties work in marshes of South Iraq . . .** Basrah Petroleum Company has made surveys in silt covered areas between the Tigris and Euphrates rivers, and other similar regions. Seismic prospecting has proved its effectiveness in the district by leading to discovery of the Zubair and Rumaila oil fields near the Kuwait border and the Persian Gulf. In the current seismic work, various types of waterborne and amphibious craft are being used, including air boats, marsh buggies, house boats, barges, and floating rafts. See . . . . . Page 121

Continued on Page 6

Oil Industry In Brief

Here are the latest economic trends, revealed by WORLD OIL *and industrial research.*

On the plus side

Demand is up. Although disappointing in some respects (May gasoline demand was up only 1.2 percent over same month last year), total demand in May increased 4.2 percent over same 1958 period. Exports were down 12 percent and domestic consumption was up 4.8 percent . . . **See Page 25.**

Rig activity continues to increase. Active rigs totaled 4,277 on May 31, an increase of 331 rigs, or 8.4 percent over same date last year . . . **See Page 28.**

Well completions increase. New well completions averaged 129 wells per day during May, for a substantial 9.2 percent increase over April—and 2.4 percent over May, 1958 . . . **See Page 28.**

Total footage is up. Footage drilled increased sharply in May, averaging 545,000 feet per day—up 38,500 feet per day or 7.6 percent over the April average . . . **See Page 28.**

Purchases are up. During the first quarter, purchases of oil country goods increased 36.9 percent over last year. However, suppliers' profits are expected to continue slim into 1960 . . . **See Page 106.**

On the minus side

Supply is excessive. Oversupply of crude oil and petroleum products totaled 59 million barrels in June, forcing a nine-day proration schedule in Texas, and seriously weakening markets. Product prices are approaching 1958 recession bottoms—and if they continue downward, crude prices also might be affected . . . **See Page 25.**

Imports are up. Although down 4.7 percent in May, total imports averaged 15.3 percent higher during first five months of 1959 than same 1958 period . . . **See Page 25.**

Costs are increasing. Average cost per well went up from $46,000 in 1955 to $50,200 in 1956. Average cost per foot drilled increased 11.9 percent in three-year period, 1954-56 . . . **See Page 120.**

New field discoveries are down. Operators discovered 419 new oil, distillate and gas fields during the first five months of this year, a decrease of 34 fields, or 7.5 percent from same period in 1958 . . . **See Page 28.**

QUICK LOOK at this issue . . .

☐ **Fluid loss controlled by acrylic polymers as drilling mud additive . . .** Acrylic polymers presently are being used as fluid loss control agents in drilling muds. In the past, polymers have been extremely sensitive to contamination and have caused high viscosity and gel strength in certain mud systems. However, continuing research is correcting these deficiencies. For an up-to-date report on recent improvements in acrylic polymers, turn to.....Page 122

☐ **Wet gas *can* be measured accurately . . .** The effect of entrained liquids on orifice meter measurement of field gas streams has been the subject of a number of tests. Known volumes of water and distillate were injected into a dry gas stream and the resulting wet gas was metered under strict conditions. A number of curves were constructed to show percent meter error versus various gas-liquid ratios. Use of correction factors from these curves should provide wet gas measurements more accurate than those now calculated by standard methods. See .....Page 130

What every 'thinking' oil man knows

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Looking Ahead

Efficiency stressed at Fifth World Congress . . . Rising drilling and production costs, improved methods and equipment, ways to curb the world crude glut, were major topics at Fifth World Petroleum Congress. Some of the more significant reports on these subjects included:

Outlook: Crude production will increase 187 percent to meet 127 percent jump in world demand. By 1975, oil and gas will supply from 58.1 to 73 percent (depending on whose paper you heard) of world energy needs, compared with slightly less than 50 percent today. At present, there is urgent need to hold back on production to strengthen price structure. However, no one can agree on a workable plan—and probably won't.

Exploration: Three government geologists predicted that eventually petroleum will be found in a 175,000-cubic-mile Atlantic offshore area beneath the Continental Shelf and possibly the emerged coastal plain . . . **Leading geologists also discussed** future of exploration, pointing up need for better correlations, more complete and accurate information on underground fluid conditions, more drilling for purely stratigraphic reasons, better oil and gas identification, more complete geologic history.

Drilling: Eight Soviet scientists presented a paper (in absentia) on new Russian drilling techniques, including an explosion method, electrodrill, slim-hole turbodrills, use of electric discharges in a fluid medium.

Explosion drilling method is said to have worked in field tests to 9,000 feet, with maximum penetration in hard dolomites and limestones up to 50 feet per hour, with average of 10-16 feet per hour. However, maximum continuous well interval in hard formations is about 950 feet. Method makes use of special explosive charges in a liquid column.

Electric discharge method, now in lab stage, makes hole by using hydraulic shock resulting from electrodes in a fluid. Russians also claim they have developed new slim hole turbodrill with 5⅝-inch and 4⅝-inch bits. They also report a new bearing design which eliminates weight on the bit, thus increasing the life of rock bit bearings. Plastic parts are being used in armatures and rotors to cut cost and corrosion.

Improvements in two types of Russian electrodrills (one uses wire line, the other drill pipe) have increased penetration rate in deep and directional holes from 14 feet per hour in 1951 to more than 40 feet per hour in 1957.

Production: Within 50 years, secondary recovery may well produce as much crude as primary recovery, according to two spokesmen for Pan American Petroleum Corporation. They added: Gas injection, thermal methods, waterflood, and improved gas drives will result in production of 85 billion more barrels of crude. Most successful methods will be improved gas drives for 35 gravity crudes and above—thermal recovery for crudes with 25 gravity or below.

Russia claims it has doubled production in past five years by proper well location and wider spacing—use of peripheral, perimeter and intracontour methods—reducing skin effects—increasing pressure in water injection wells—decreasing bottomhole pressure at producing wells—improved hydraulic fracturing methods.

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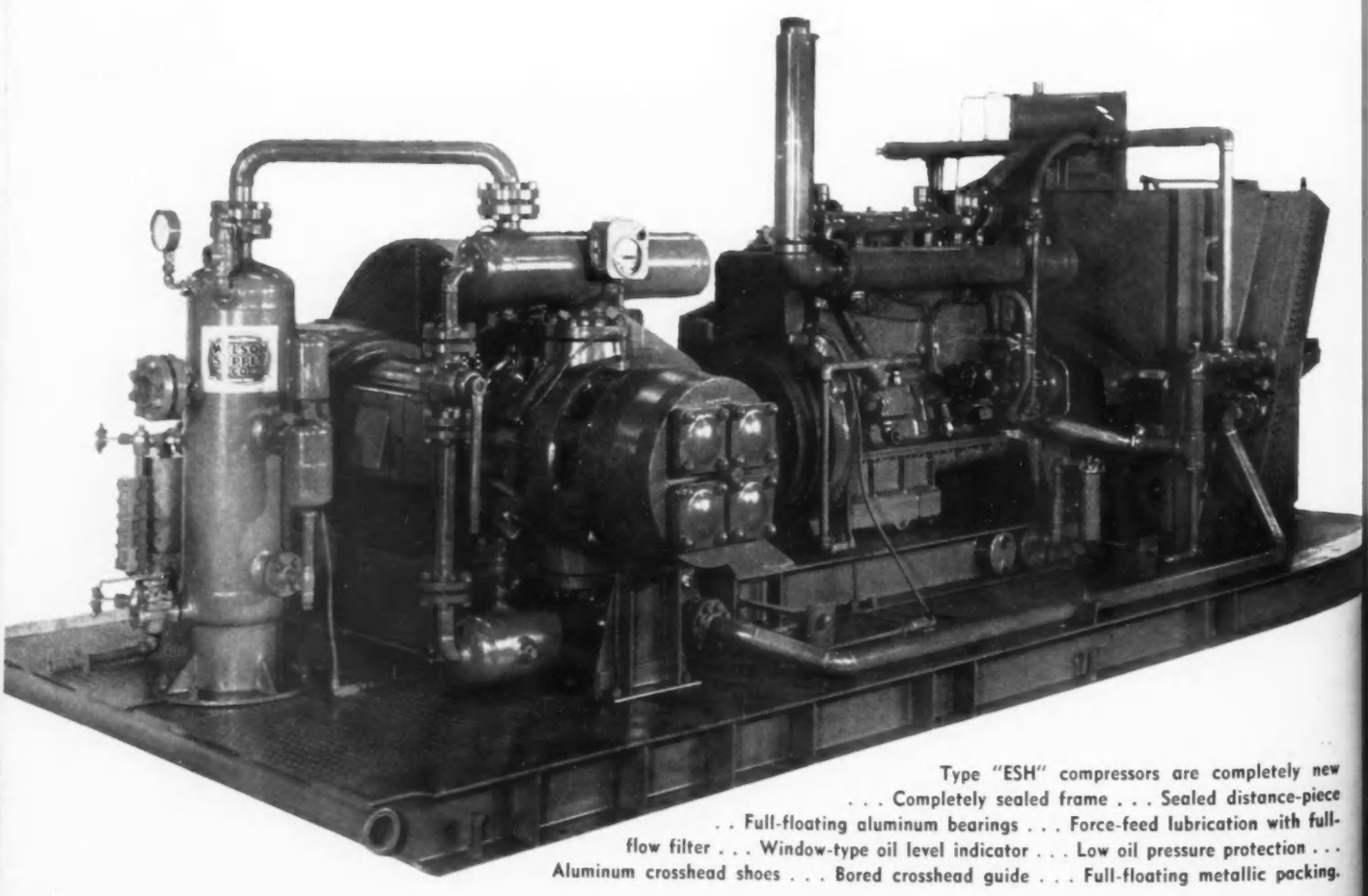
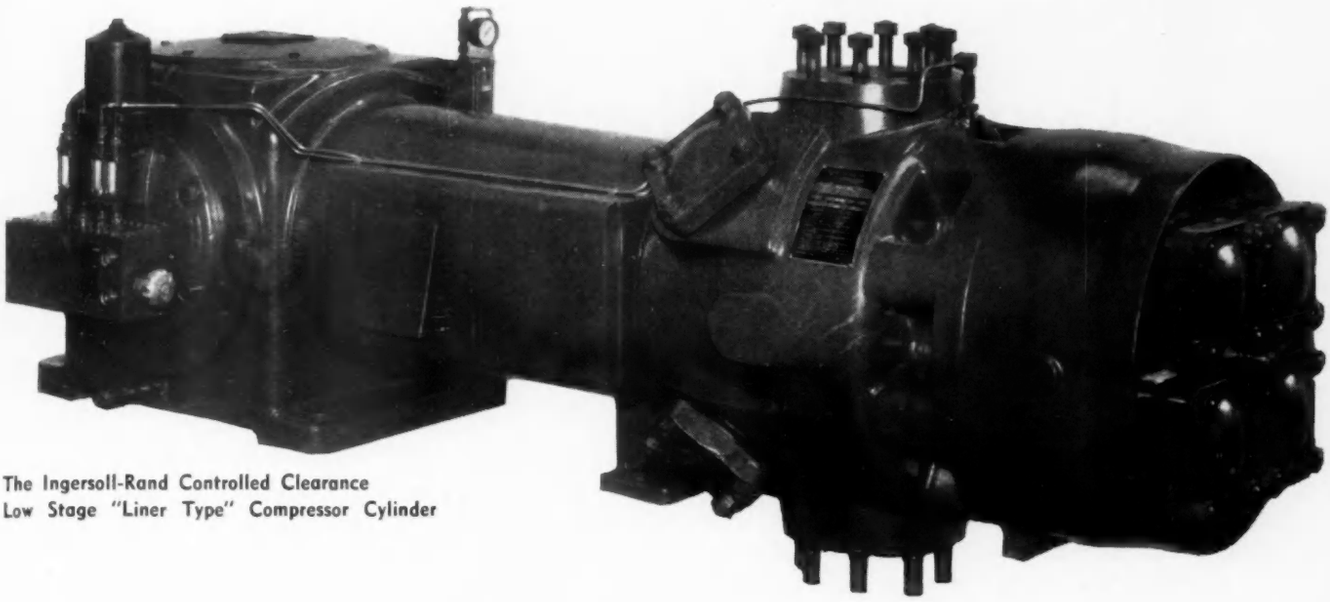


Type "ESH" compressors are completely new . . . Completely sealed frame . . . Sealed distance-piece . . Full-floating aluminum bearings . . . Force-feed lubrication with full-flow filter . . . Window-type oil level indicator . . . Low oil pressure protection . . . Aluminum crosshead shoes . . . Bored crosshead guide . . . Full-floating metallic packing.



The Ingersoll-Rand Controlled Clearance
Low Stage "Liner Type" Compressor Cylinder

. . . AND HERE'S WHY

The new low stage "liner type" compressor cylinder is the companion to the Ingersoll-Rand high pressure cylinder. It makes your Wilson Supply-Ingersoll-Rand packaged compressor more flexible. With "controlled clearance," the low stage "liner type" cylinder is capable of handling any application where the discharge pressure is between 150 lbs. and 500 lbs. You change **ONLY** the liners and/or clearance . . . real savings in money and time for you. A liner costs a lot less than a new cylinder. It can be changed in the field with a minimum shut-down time.

Get the full story on FLEXIBLE Wilson Supply-Ingersoll-Rand packaged compressors. Contact your nearest Wilson Supply Company store or write . . . COMPRESSOR DIVISION, Wilson Supply Company, P. O. Drawer 19, Houston, Texas . . . for detailed information. Please include suction, discharge pressure and volume to be handled.

"WHAT YOU WANT—WHEN YOU WANT IT"

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WILSON SUPPLY CO
HOUSTON, TEXAS

Good Wells Make Good News

Recent Treatments Engineered With the Aid of the "Frac Guide"

July 1, 1959

The "Frac Guide*" -- a Dowell-developed manual used in engineering frac jobs -- is revolutionizing fracturing techniques. Here are four recent treatments that show improved results obtained with the "Frac Guide."

- **Atascosa County, South Texas** (Old Oil Well) This well was completed into the Navarro formation at 5043 feet. After production had dropped to almost nothing, the well was refractured. 15,000 gallons of lease crude and 30,000 pounds of sand failed to help. Then Dowell engineered a treatment with the "Frac Guide." Riverfrac* was selected as the frac service; and 100,000 gallons of fresh water and 100,000 pounds sand were injected down casing, creating a calculated fracture area of 126,000 square feet. Production climbed to an average of 21 bopd and showed no sign of decline after 60 days. Treatment paid out in about 65 days.

- **Beaver County, Oklahoma Panhandle** (New Gas Well) This well, completed through perforations into the Lower Morrow sand at 7831-46 feet, tested 750,000 cfd open flow. Dowell engineers designed a treatment with the "Frac Guide" and recommended Waterfrac. 10,000 gallons of thickened water and 44,000 pounds sand were pumped into the well, creating a calculated fracture area of 50,000 square feet. After clean-up, production was 35 mmcfd on potential test. Other wells in the area, fractured with 20,000 gallons gelled oil and 20,000 pounds of sand -- the standard treatment in the Lower Morrow before the advent of the "Frac Guide" -- usually test only about 8 mmcfd.

- **Natrona County, Wyoming** (New Oil Well) This well produced only 16 bopd from the Second Wall Creek formation at 4256 feet. With the "Frac Guide", Dowell engineered a treatment using Sandfrac*. 38,000 gallons of lease oil with F.L.A.* (Fluid Loss Additive) and 105,000 pounds of sand were injected into the well. The calculated fracture area created was 123,000 square feet. Production 60 days after treatment was 65 bopd. Smaller jobs in this field, using only 1½ pounds of sand per gallon, usually result in only about 35 bopd.

- **Alberta, Canada** (Old Oil Well) Based on core analysis and previous experience, a major operator considered abandoning a well completed in the Cardium at about 4411 feet. Then Dowell engineered a treatment using the "Frac Guide", and injected 5000 gallons of 40 gravity lease crude carrying 25,000 pounds of sand down tubing. A calculated fracture area of 36,000 square feet was created. The operator feels certain that the well will now make its allowable; and that a commercial well could not have been obtained using previous fracturing techniques.

Let your Dowell engineer help you plan your next fracturing job. There is no additional cost. Contact the Dowell office or station nearest you. There are more than 165 locations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma. *Dowell Trademark.

Services for the oil industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY

The second mile—and you

"Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession."

With these words Dr. W. E. Wickenden, president of Case Institute of Technology until his death, once defined before the Engineering Institute of Canada the extra endeavor by which men may excel. And he went back more than 1,900 years for his text, which was from the Sermon on the Mount—"Whosoever shall compel thee to go one mile—go with him twain."

To benefit from industry as an individual, one must assure himself that industry, in turn, is benefiting from him. It is a two-way thoroughfare.

How to do that calls for appraisal and improvement. And toward that end, help has been offered by the Professional and Training Committee of the Engineers Council for Professional Development. In a recent brochure, the ECPD supplied 40 questions concerning one's job, his profession, his personal development, and his general program of development.

One advantage of this self evaluation program is that it can be used by anyone, regardless of his job or position.

However, specifically designed for the field of engineering, the brochure contains eight questions which will materially assist in self evaluating one's own profession. This section of the brochure deals primarily with an individual's relation to his professional societies, his responsibility to them, and the advantages they offer him and his industry.

Since the professional society can offer great help in assisting an individual to cover the "second mile," these eight questions are listed below.

1. Am I a member of my professional society? Do I understand its aims?

2. What requirements for the next higher grade of membership in my professional society do I now fail to satisfy? What steps, beyond those already planned, should I take to correct my present deficiencies? When should I plan to attain full society membership? Are there other professional societies in whose activities I do or should participate?

3. What are my responsibilities to the other members of my profession? What service do they have a reasonable right to expect of me?

4. Am I taking advantage of the benefits offered to me through the professional societies by others of my profession?

5. Is my program of reading adequate to keep me abreast of technological progress in fields which bear on the work of my career?

6. What have I done to familiarize myself with the performance standards of a professional engineer, and how have I applied these standards to my own work?

7. Does my position and do my ambitions make it desirable for me to be a registered professional engineer? If so, what further steps should I take toward qualifications: and when?

8. Am I a good representative of my profession in my community?

There is little doubt that many advancements in the oil industry owe considerable to the efforts of professional societies and to their aims. Therefore, frequent self appraisal of one's own value to the industry and the fuller understanding of what professional societies offer can only lead to a significant improvement in both the individual and industry.

" . . . advanced technology and methods"

"In an industry such as ours, an industry whose accomplishments are little short of phenomenal, it is difficult to praise any one segment without deep consideration.

"Great contributions have been made by all elements. Cooperation between operating companies, manufacturers, drilling contractors, and service and supply companies has made possible the growth and progress our industry enjoys.

"Service companies, for instance, have given us advanced technology and methods for finding and producing oil and gas. These services are available when and where they are needed, at any time day or night, in any weather.

"Behind each drilling rig, each refinery, each gas plant or pipe line operation stands the manufacturer, the supplier and the service man. They provide engineering, research, products and services to keep the industry humming.

"As I said, it's hard to praise just one segment of the industry, but one thing is certain, all our jobs have been made easier and better because of the companies and men who give the service."

J. L. LATIMER,
President,
Magnolia Petroleum Company

P.E.S.A.*

* PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

PROUD TO BE PART OF A PIONEERING INDUSTRY

Excessive supplies cause weak markets

AN INCREASINGLY serious oversupply of crude oil and petroleum products in the United States was made evident when the Texas Railroad Commission on June 18 made a further drastic reduction in allowable crude production in Texas in July.

The commission set the state allowable at 2,666,771 barrels daily for July, a cut of 226,044 barrels, by ordering only 9 producing days in the 31 day month. One month previously the commission had cut Texas allowable output by 282,414 barrels daily, by ordering only 10 producing days out of the 30 in June, compared with 12 producing days in May.

Major companies indicated reduced need for crude because lagging demand for products was requiring lower refinery runs.

The commission said stocks of crude and products were excessive by 59 million barrels, with gasoline accounting for half of the excess.

Markets Weak. U.S. petroleum industry markets further weakened during May and the first half of June. They have been depressed by surpluses of crude oil and refined products, resulting from excessive production and refinery runs.

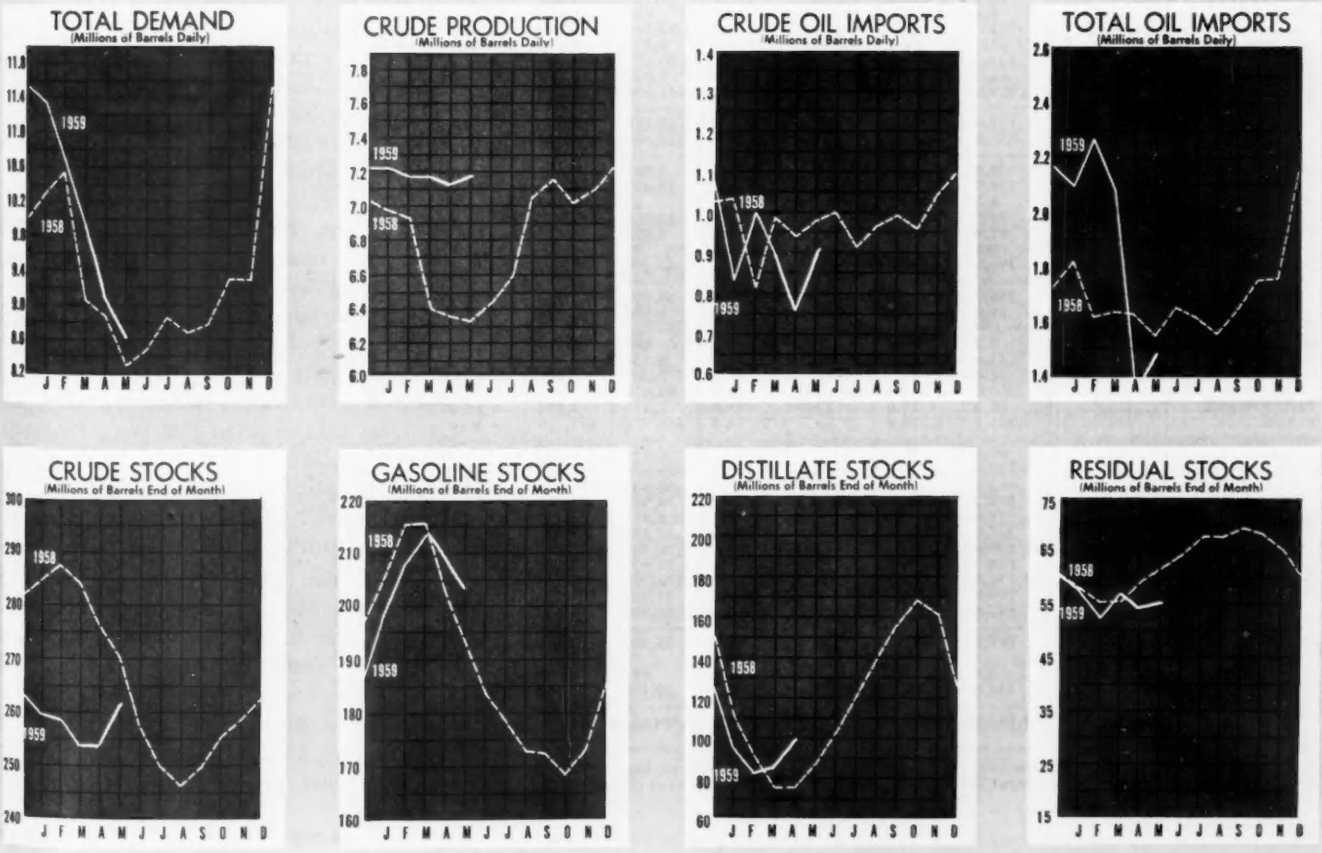
Prices of nearly all products except residual fuel oil have worked lower and approached the 1958 depression bottoms. In recent weeks there has been speculation that if product prices continued weak or further deteriorated, then crude oil prices also might be reduced.

Supplies usually exceed demand in May and June, when consumption is at the lowest levels of the year. But this year the May-June supply excess has been exceptionally large.

World Surpluses. Adding to the seriousness of petroleum surpluses in the United States is the great oversupply of oils available in the world markets. Potential production far exceeds current market requirements. Seeking more markets are the flush fields of Venezuela and Western Canada, the mammoth fields of the Middle East, and some fields in Communist countries.

Likely to come into the world market with large volumes of petroleum within the next few years, in addition, are the huge fields now

Petroleum Trends...



U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	May 1959	May 1958	% Diff.	Apr. 1959	January-May 1959	January-May 1958	% Diff.
DEMAND							
All Oils, Total Demand	8,651	8,302	+ 4.2	9,092	9,923	9,401	+ 5.6
Domestic Demand	8,406	8,023	+ 4.8	8,857	9,678	9,133	+ 6.0
Export Demand	245	279	—12.2	235	245	268	— 8.6
Gasoline, Total Demand	4,157	4,106	+ 1.2	4,076	3,902	3,748	+ 4.1
Distillate, Total Demand	1,337	1,253	+ 6.7	1,660	2,194	2,117	+ 3.6
Kerosine, Total Demand	132	143	— 7.7	188	342	370	— 7.6
Residual, Total Demand	1,384	1,236	+12.0	1,511	1,829	1,529	+19.6
CHANGE IN STOCKS							
All Oils, Change in Stocks	—865	—183	....	—223	— 20	—487	....
NEW SUPPLY							
Total New Supply	9,516	8,485	+12.2	9,315	9,943	8,914	+11.5
Domestic Production, Total	8,033	6,980	+15.1	7,991	8,053	7,276	+10.7
Crude Oil	7,183	6,233	+15.2	7,126	7,183	6,489	+10.7
Natural Gas Liquids	850	747	+13.8	865	870	787	+ 0.5
Imports, Total	1,483	1,556	— 4.7	1,324	1,889	1,638	+15.3
Refined Products	559	571	— 2.1	565	978	703	+39.1
Crude Oil, Total	924	935	— 1.2	759	912	935	— 2.5
Crude, East Coast	754	752	+ 0.3	579	721	776	— 7.1
CRUDE RUNS							
Crude Runs to Stills	7,843	7,411	+ 5.8	7,863	8,054	7,430	+ 8.4
Domestic Crude	6,947	6,489	+ 7.1	6,933	7,118	6,517	+ 9.2
Foreign Crude	896	922	— 2.8	930	936	913	+ 2.5

U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. May 1959	TOTAL IN U.S. May 1958	TOTAL IN U.S. % Diff.	TOTAL IN U.S. Apr. 1959	EAST OF CALIFORNIA May 1959	EAST OF CALIFORNIA May 1958	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA Apr. 1959
All Oils	786.3	767.8	+ 2.4	759.5	.....	.....	.....	.....
Crude Oil	262.4	263.1	— 0.3	254.2	226.7	219.4	+ 3.3	216.2
Gasoline	203.3	195.2	+ 4.1	209.6	174.1	168.1	+ 3.6	180.1
Distillate Fuel Oil	99.6	89.2	+11.6	85.6	90.1	76.7	+17.5	74.7
Kerosine	24.7	21.4	+15.5	21.1	24.0	21.1	+13.7	20.6
Residual Fuel Oil	55.1	61.6	—10.6	54.5	28.5	29.8	— 4.4	27.5
Other Oils	141.2	137.3	+ 2.8	134.5	.....	.....	.....	.....

U.S. Crude Oil Production, by States (Thous. Bbls.)

STATE or DISTRICT	Daily Average For Month May 1959	May 1958	% Diff.	April 1959	Total, January-May 1959	1958	% Diff.
Alabama	16.3	14.8	+ 10.1	16.4	2,063	2,386	— 13.5
Arkansas	81.1	72.8	+ 11.4	81.0	11,846	12,019	— 1.4
California	839.6	849.5	— 1.2	837.6	126,973	132,326	— 4.1
Colorado	128.4	132.2	— 2.9	127.6	19,221	20,577	— 6.6
Florida	1.2	1.2	.....	1.2	178	189	— 5.8
Illinois	212.5	221.5	— 4.1	219.3	32,749	33,713	— 2.9
Indiana	31.4	31.6	— 0.6	31.6	4,853	4,825	+ 0.6
Kansas	324.5	322.5	+ 0.6	341.5	50,471	47,678	+ 5.9
Kentucky	64.9	43.6	+ 48.9	63.5	9,820	6,527	+ 50.5
Louisiana	969.4	807.7	+ 20.0	960.8	142,878	124,616	+ 14.7
North Louisiana	117.0	120.3	— 2.3	115.2	18,188	17,361	+ 4.8
South Louisiana	852.4	687.4	+ 24.0	845.6	124,690	107,255	+ 16.3
Michigan	26.5	25.2	+ 5.2	25.3	3,889	3,847	+ 1.2
Mississippi	126.7	90.1	+ 40.6	122.7	18,470	14,671	+ 25.9
Mo.-S. Dak.-Tenn.	0.3	0.3	.....	0.3	23	52	— 55.8
Montana	78.1	77.3	+ 1.0	81.1	12,234	11,473	+ 6.6
Nebraska	61.9	51.7	+ 19.7	56.7	8,673	7,917	+ 9.5
Nevada-Wash.-Alaska	0.5	.....	.....	0.5	90	17	+429.4
New Mexico	296.3	269.6	+ 9.9	294.2	43,299	39,282	+ 10.2
Southeast New Mexico	258.7	237.4	+ 9.0	257.3	38,103	37,158	+ 2.5
Northwest New Mexico	37.6	32.2	+ 16.9	36.8	5,196	2,124	+144.6
New York	5.2	6.6	— 21.2	5.1	805	982	— 18.0
North Dakota	33.6	37.9	— 11.4	38.5	6,656	5,973	+ 11.4
Ohio	14.6	17.5	— 16.6	15.1	2,261	2,602	— 13.1
Oklahoma	560.8	546.7	+ 2.6	564.1	84,838	83,195	+ 2.0
Pennsylvania	16.4	19.0	— 13.7	15.8	2,416	2,874	— 15.9
Texas	2,845.1	2,220.0	+ 28.2	2,774.5	431,938	371,119	+ 16.4
Dist. 1: South Central	47.0	45.5	+ 3.3	47.2	6,927	6,949	— 0.3
Dist. 2: Middle Gulf	128.8	95.9	+ 34.3	122.1	19,158	16,701	+ 14.7
Dist. 3: Upper Gulf	402.3	346.7	+ 16.0	394.6	61,684	56,276	+ 9.6
Dist. 4: Lower Gulf	201.2	160.6	+ 25.3	202.9	30,948	27,186	+ 13.8
Dist. 5: East Central	32.1	25.6	+ 25.4	31.5	4,813	4,478	+ 7.5
Dist. 6: Northeast	283.6	214.4	+ 32.3	280.6	43,391	37,391	+ 16.0
Dist. 7-B: North Central	139.6	122.4	+ 14.1	145.2	27,967	20,408	+ 37.0
Dist. 7-C: West Central	138.3	114.1	+ 21.2	131.6	20,929	19,370	+ 8.0
Dist. 8: West	1,155.9	779.4	+ 48.3	1,104.8	171,276	132,174	+ 29.6
Dist. 9: North	208.7	191.8	+ 8.8	206.2	31,536	29,374	+ 7.4
Dist. 10: Panhandle	107.6	106.8	+ 0.7	107.8	16,200	16,138	+ 0.4
Utah	107.3	70.6	+ 52.0	106.9	16,359	4,650	+251.8
Virginia	.....	.....	.....	.....	2	3	— 33.3
West Virginia	5.9	5.9	.....	6.1	884	895	— 1.2
Wyoming	334.4	296.9	+ 12.6	339.1	50,776	45,371	+ 11.9
Total, U.S.	7,182.9	6,232.7	+ 15.2	7,126.5	1,084,665	979,779	+ 10.7

Sources for above 3 tables: Bureau of Mines monthly reports, except last 2 months based on API and B. of M. weekly reports and WORLD OIL estimates, and all Texas district data from API.

opening up in Northern Africa's Sahara Desert.

In view of all these rich sources, it is indicated that world petroleum supplies will far exceed demand at least for several years, even though consumption is steadily increasing in virtually all countries. So great are the present and prospective potentials of the oil fields of the world that some oil men foresee oversupplies for possibly 10 years or longer.

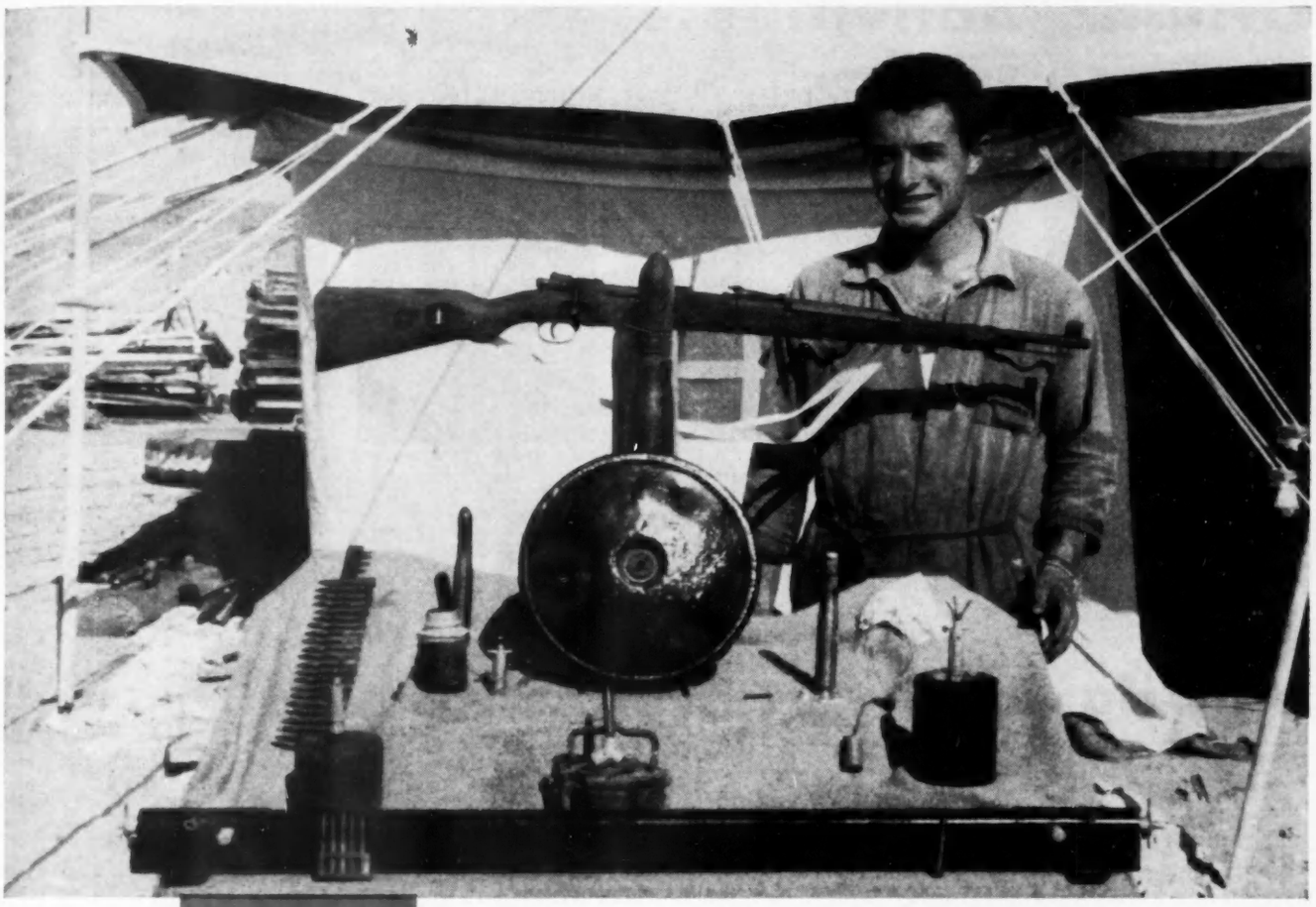
Under import controls the U.S. oil industry now is effectively protected from excessive volumes of oils from abroad. But even U.S. fields have large surplus producing ability. This has been proved in the past few months, as actual production and refinery runs have substantially exceeded market demand.

Demand. Total demand on the U.S. industry for all oils in May was 4.2 percent above that month last year, with exports down 12 percent but domestic consumption up 4.8 percent. The demand for gasoline, the industry's principal product, was disappointing, as it was only 1.2 percent above May last year. Distillate fuel oil demand was up 6.7 percent. Kerosine demand continued under last year. Residual fuel oil demand was up 12 percent.

These changes in demand were less favorable than in earlier months. For the first five months of 1959 combined, total demand was up 5.6 percent, with domestic use 6 percent higher; and there were gains of 4.1 percent for gasoline demand, 3.6 percent for distillate, and 19.6 percent for residual.

Supply. New supply has increased much more sharply than demand, with ill effects on stocks. Total imports were off 4.7 percent in May, but they had been excessive in the early part of this year, and for the first five months they were 15.3 percent greater than last year. Domestic production of crude oil and natural gas liquids was up 15.1 percent in May and 10.7 percent for the first five months.

Crude runs to stills were up 5.8 percent in May and 8.4 percent for the first five months. Total stocks of crude and products were increased by an average of 865,000 barrels daily in May, in contrast with a gain of only 183,000 daily in that month last year.



Libyan Sands Yield Forgotten Arsenal

. . . to GSI crews in their search for oil

Before they can probe the subsurface for geophysical data, GSI field parties in Libya must probe the desert sands for dangerous remnants of World War II.

German Teller mines, British, French, and Italian bombs, artillery shells and other relics of desert fighting are turned up by GSI mine clearance parties in advance of geophysical exploration.

Uncovering and disarming anti-tank and personnel mines isn't usually considered part of a geophysicist's job, but, to get the data its client needs, GSI has taken mine clearance in its stride. GSI counts among its demolition experts former members of the British Eighth Army and Rommel's Afrika Corps... now working side by side to reap what they had sown nearly twenty years ago.

In all fields of exploration GSI has the experts and the facilities to get the job done the way it must be done.

GEOPHYSICAL SERVICE INC.

900 EXCHANGE BANK BUILDING • DALLAS 35, TEXAS

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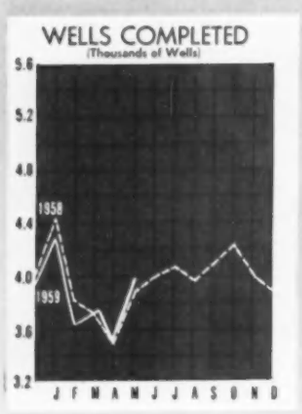
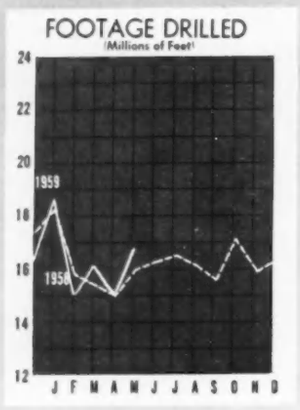
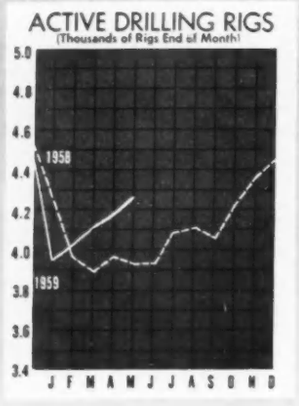
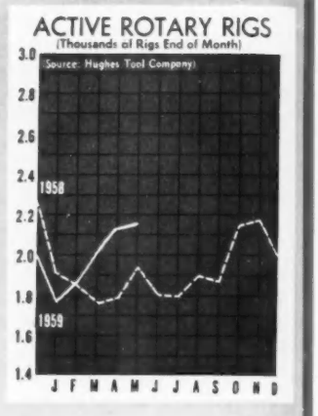
Drilling Activities...









May rig activity at five-month high

OVERSUPPLY, EXCESSIVE productive capacity and fluctuating proration schedules have failed to curb a steady three-month upturn in U.S. rig activity.

Total active rigs reached a 1959 high of 4,277 on May 31, up 102 rigs, or 2.4 percent over the total reported on April 30, and 331 rigs, or 8.4 percent more than the May 31, 1958 total of 3,946 rigs. An average of 4,076 rigs were active during the first five months of this year, an increase of 115 rigs, or 2.9 percent over the 3,961-rig average reported during the same 1958 period.

New well completions averaged 129 wells per day during May, for a substantial 9.2 percent increase over the April average of 118 wells per day. The May average was also up 2.4 percent over the 126 wells per day reported during May, 1958.

After a three-month steady decline, total footage drilled increased sharply during May, averaging about 545,000 feet per day—up 38,500 feet per day or 7.6 percent over the April average. During the first five months of 1959, footage drilled totaled 81.8 million feet, up 1.5 percent from the same period in 1958.

Operators discovered 419 new oil, distillate and gas fields through May, a decrease of 34 fields, or 7.5 percent from the same five-month period in 1958.

Summary of U.S. Drilling Activity

ITEM	May 1959	April 1959	FIVE MONTHS JANUARY–MAY 1959	1958	% Diff.
New Wells Completed:					
Oil	2,015	1,794	9,842	9,676	+ 1.7
Distillate	56	77	344	343	+ 0.3
Gas	343	307	1,545	1,667	— 7.3
Service	83	65	387	532	—27.3
Dry	1,513	1,326	7,151	7,009	+ 2.0
Total Wells	**4,010**	**3,569**	**19,269**	**19,227**	**+ 0.2**
Footage Drilled (Min. of Feet)	**16.9**	**15.2**	**81.8**	**80.6**	**+ 1.5**

Summary of U.S. Wildcat Drilling

ITEM	May 1959	April 1959	FIVE MONTHS JANUARY–MAY 1959	1958	% Diff.
New Field Discoveries:					
Oil	71	41	278	310	—10.3
Distillate	5	6	38	45	—15.6
Gas	13	22	103	98	+ 5.1
Total Discoveries	**89**	**69**	**419**	**453**	**— 7.5**
Dry Wildcats	688	654	3,389	3,387	+ 0.1
Total Wildcats	**777**	**723**	**3,808**	**3,840**	**— 0.8**
Percent Productive	11.5	9.5	11.0	11.8	.....
Percent Dry	88.5	90.5	89.0	88.2	.....

U.S. Drilling Activity in April and First Five Months, 1959-1958

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR MAY, 1958 Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS May 1959	April 1959	May 1958	Total Footage May 1959	DETAILS FOR JANUARY-MAY NEW WELLS 1959	1958	Percent Diff.	FOOTAGE 1959	1958	WILDCAT DRILLING IN MAY AND FIRST FIVE MONTHS, 1959-1958: DETAILS FOR MAY, 1959 Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-MAY Oil	Dist.	Gas	Dry	TOTAL WILDCATS 1959	1958	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down) May 31, 1959	April 30, 1959	May 31, 1958
Alabama	6	....	....	3	....	9	6	6	74,477	45	31	+ 45.2	439,091	273,347	....	....	....	3	3	....	....	....	9	9	11	14	14	10
Alaska	....	....	....	1	....	1	1	....	12,037	4	....	....	49,305	....	....	....	....	1	1	1	....	....	3	4	....	3	3	....
Arkansas	25	....	3	24	....	52	61	62	164,941	317	263	+ 20.5	1,031,238	906,150	....	....	....	6	6	1	....	....	41	43	65	47	42	58
California	92	....	5	41	2	140	95	118	652,993	585	640	— 8.6	2,787,129	2,982,009	1	....	....	26	27	1	....	1	99	104	102	152	144	136
Colorado	11	....	7	41	....	59	57	60	302,836	282	300	— 6.0	1,487,193	1,586,911	1	....	....	29	30	10	....	5	141	156	148	66	54	54
Florida	....	....	....	....	....	....	2	....	....	3	2	+ 50.0	17,351	18,942	....	....	....	....	....	....	....	....	3	3	2	3	3	1
Georgia	....	....	....	....	....	....	....	....	....	1	....	....	990	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....
Illinois	86	....	....	88	....	174	155	191	398,600	783	819	— 4.4	1,762,261	1,845,032	1	....	....	34	35	3	....	....	180	183	220	239	239	268
Indiana	29	....	....	41	....	70	76	59	125,074	317	253	+ 25.3	528,299	410,880	....	....	....	19	19	....	....	1	81	82	66	80	60	95
Kansas	148	....	15	157	4	324	280	324	1,199,210	1,496	1,345	+ 11.2	5,474,925	4,616,651	20	....	2	78	100	62	....	10	373	445	355	285	281	306
Kentucky	39	....	16	52	....	107	117	105	171,829	624	489	+ 27.6	877,000	688,616	2	....	....	5	7	6	....	....	30	36	28	143	142	109
Louisiana	126	11	17	126	....	280	268	269	2,111,088	1,460	1,362	+ 7.2	11,489,135	11,389,206	1	1	1	35	38	15	7	4	161	187	213	389	388	328
North Louisiana	59	1	11	49	....	120	87	82	443,753	525	448	+ 17.2	1,896,636	1,724,184	1	....	....	11	12	7	1	....	46	54	48	71	60	92
South Louisiana	67	10	6	77	....	160	181	187	1,667,335	935	914	+ 2.3	9,592,499	9,665,022	....	1	1	24	26	8	6	4	115	133	165	318	328	256
* Gulf of Mexico	23	....	1	6	....	30	38	44	302,178	194	218	— 11.0	1,936,811	2,099,699	....	....	1	1	2	1	1	2	11	15	19	54	52	50
Michigan	18	....	10	12	....	40	28	45	114,317	198	151	+ 31.1	582,738	435,949	....	....	....	4	4	2	....	....	48	50	46	88	80	73
Mississippi	18	1	4	27	....	50	55	19	453,214	257	149	+ 72.5	2,380,668	1,298,151	....	....	2	15	17	6	....	2	86	94	68	66	59	46
Missouri	....	....	....	1	....	1	....	....	726	3	6	— 50.0	2,090	3,255	....	....	....	....	....	....	....	....	1	1	1	1	....	1
Montana	7	....	....	9	....	16	17	26	82,169	110	131	— 16.0	523,584	737,262	....	....	....	5	5	....	....	....	39	39	55	44	46	35
Nebraska	22	....	....	58	....	80	58	60	483,636	297	231	+ 28.6	1,761,130	1,378,617	2	....	....	36	38	13	....	....	126	139	110	38	43	40
New Mexico	100	....	14	58	....	172	120	125	647,803	682	793	+ 14.0	2,750,471	3,797,557	6	....	....	23	29	19	1	4	76	100	116	183	191	199
Southeast	63	....	3	23	....	89	80	76	367,756	385	424	— 9.2	1,755,446	2,143,902	5	....	....	12	17	14	....	....	55	69	66	111	95	75
Northwest	37	....	11	35	....	83	40	49	280,047	297	369	— 19.5	995,025	1,653,655	1	....	....	11	12	5	1	4	21	31	50	72	96	124
New York	24	....	1	2	18	45	45	45	53,400	225	225	....	267,000	267,000	....	....	....	....	....	....	....	....	....	....	....	42	42	42
North Dakota	36	....	....	16	....	52	28	35	324,449	183	168	+ 8.9	1,120,527	1,151,297	5	....	....	7	12	9	....	....	29	38	48	45	46	36
Ohio	35	....	30	17	....	82	69	74	222,718	367	391	— 6.1	1,001,801	1,014,019	....	....	....	....	....	4	....	1	3	8	3	213	208	218
Oklahoma	251	3	46	185	7	492	427	589	1,714,171	2,595	2,906	— 10.7	8,838,984	9,307,598	6	....	1	52	59	26	6	17	301	350	297	494	457	447
Pennsylvania	12	....	27	4	6	49	47	58	176,067	236	293	— 19.5	793,593	875,490	....	....	1	....	1	....	....	2	4	6	10	147	182	174
South Dakota	....	....	....	....	....	....	1	....	....	6	3	+ 50.0	22,749	16,991	....	....	....	....	....	....	....	....	4	4	3	2	2	1
Tennessee	....	....	1	4	....	5	5	5	6,000	25	25	....	30,000	31,100	....	....	....	2	2	....	....	....	10	10	10	....	....	....
Texas	873	41	102	500	46	1,562	1,448	1,476	6,804,998	7,464	7,412	+ 0.7	32,796,352	32,156,154	24	4	6	288	322	93	23	44	1,424	1,584	1,733	1,084	1,091	935
Dist. 1: South Central	41	1	6	45	....	93	69	80	205,621	430	425	+ 1.2	1,070,025	1,070,819	1	....	....	32	33	3	....	1	125	129	156	42	40	31
Dist. 2: Middle Gulf	17	8	15	35	....	75	72	76	427,004	325	326	— 0.3	1,915,628	1,962,024	....	....	....	22	22	6	5	6	92	109	96	63	62	26
Dist. 3: Upper Gulf	50	14	13	43	....	120	105	122	816,392	491	566	— 13.3	3,617,768	3,525,532	2	3	2	14	21	3	13	6	90	112	140	95	96	75
* Gulf of Mexico	....	....	1	....	....	1	....	2	11,005	1	5	— 80.0	11,005	37,287	....	....	1	....	1	....	....	1	....	1	3	....	1	2
Dist. 4: Lower Gulf-S.W.	54	18	16	49	....	137	106	123	702,019	553	521	+ 6.1	3,000,578	2,683,984	....	1	2	34	37	6	4	5	159	174	208	87	92	63
* Gulf of Mexico	....	....	....	....	....	....	....	....	....	....	4	—100.0	....	49,059	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Dist. 5: East Central	3	....	....	7	....	10	9	13	49,403	53	65	— 18.5	290,914	252,418	....	....	....	7	7	....	....	....	....	....	1	....	....	2
Dist. 6: Northeast	33	....	5	21	....	59	69	71	317,152	321	362	— 11.3	1,816,769	1,910,379	....	....	....	9	9	2	....	2	62	66	94	57	55	61
Dist. 7-B: North Central	108	....	7	89	....	204	195	177	655,564	1,023	884	+ 15.7	3,251,607	2,898,811	12	....	2	55	69	31	....	6	293	330	314	103	95	70
Dist. 7-C: West Central	42	....	3	21	2	68	49	52	284,583	285	336	— 15.2	1,199,193	1,753,977	....	....	....	15	15	6	....	6	79	91	102	78	72	60
Dist. 8: West	299	....	14	60	10	383	386	388	1,985,767	2,037	1,824	+ 11.7	10,125,250	8,926,170	6	....	....	34	40	24	....	3	216	243	222	287	308	292
Dist. 9: North	175	....	8	111	34	328	303	278	971,291	1,486	1,573	— 5.5	4,303,623	4,758,606	3	....	....	55	58	7	....	1	235	243	304	177	168	158
Dist. 10: Panhandle	51	....	15	19	....	85	85	96	390,202	460	530	— 13.2	2,204,997	2,413,434	....	....	....	11	11	5	1	8	48	62	60	90	94	89
Utah	15	....	4	3	....	22	26	27	110,415	131	198	— 33.8	751,822	1,110,000	1	....	....	2	3	1	....	1	32	34	36	43	44	34
Washington	....	....	....	....	....	....	....	....	....	....	4	....	....	20,794	....	....	....	....	....	....	....	....	....	....	3	....	....	....
West Virginia	17	....	39	19	....	75	39	71	181,109	302	354	— 14.7	768,841	948,532	....	....	....	....	....	....	....	....	....	....	4	225	195	213
Wyoming	25	....	2	24	....	51	37	44	271,489	269	276	— 2.5	1,430,764	1,275,000	1	....	....	18	19	6	1	7	83	97	80	121	104	79
Others	....	....	....	....	....	....	1	3	.....	2	7	— 71.4	4,583	26,252	....	....	....	....	....	....	....	....	1	1	7	20	15	8
Total United States	2,015	56	343	1,513	83	4,010	3,569	3,896	16,859,766	19,269	19,227	+ 0.2	81,771,614	80,568,762	71	5	13	688	777	278	38	103	3,389	3,808	3,840	4,277	4,175	3,946
Total Western Canada	150	....	20	75	5	250	121	218	1,305,000	1,038	974	+ 6.6	5,406,530	4,899,390	....	....	....	....	....	....	....	....	....	....	....	191	199	215

* Gulf of Mexico wells are included in their respective district totals.

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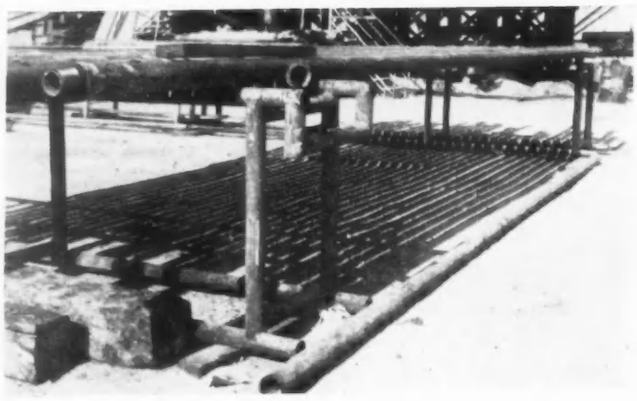
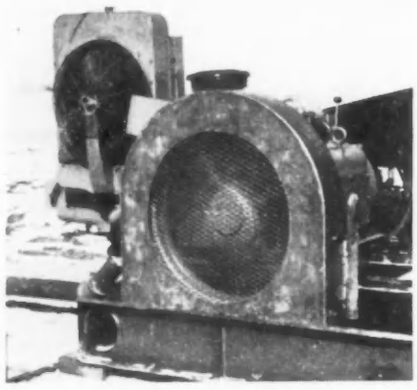
Improved Support Holds Heaviest Skids



Additional insurance against the possibility of the skids slipping out of their supports when hit a glancing blow by casing or drill pipe is contained in the rack improvement devised by one contractor. Instead of the usual small notch or slot in the side of the rack in which a plank can be rested, he fabricated a much deeper and wider shelf that can accommodate wider and heavier timbers, up to 6 x 6's or heavier if necessary.

Shown in the photograph, the modified shelf requires a slight amount of additional drill pipe material and more welding, but it remains an integral part of the rack; requires no make-shift blocking or other temporary measures each time a truck is loaded or unloaded.



Mounted Flywheel Guard Can Prevent Accidents

This neat, safe flywheel guard was constructed from salvaged tank decking and expanded metal. The guard is pinned on each side to supports made from 2-inch pipe welded to the engine base.

The inside of the guard has a horseshoe shaped piece of decking welded to it for rigidity. With this type of guard on the flywheel, it is virtually impossible for a man or his tools to come into contact with the flywheel while working on or around the engine.

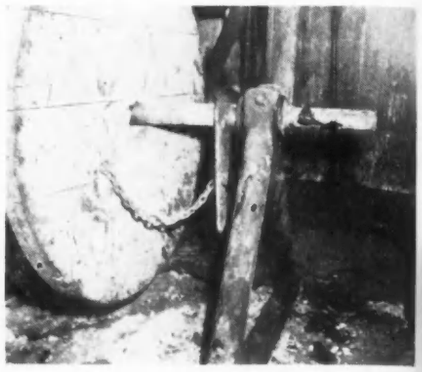
Prevent Sulfur Deposit on Aereator with Crude Oil

When forced-draft aereators are used for the removal of hydrogen sulfide from water, the trays accumulate deposits of elemental sulfur which is almost impossible to remove, sometimes requiring the use of chipping hammers.

This difficulty can be overcome by saturating the wooden trays with crude oil before use to prevent the sulfur from sticking. Any sulfur which does stick on the trays is readily removed if it is allowed to dry for a day or two before removal is attempted. The drying period allows the sulfur to dehydrate and become powdery, after which it can be brushed off the tray.

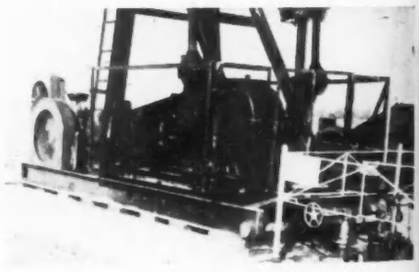
Use Air Tongs to Help In Spooling Wire Line

Spooling wire rope back on the original reel is greatly simplified by the contractor operating a workover rig through the use of his air tongs. The reel is supported in U-shaped bearings on a conventional rack made of drill pipe material.



The arbor, or axle, on which the reel turns, however, was modified as follows: A turning arm, consisting of an 18-inch length of ¾-inch flat bar stock welded to the arbor as shown in the photograph, is connected by a short chain to the reel. A slot in the turning arm permits positioning the bolt at any point depending upon the torque desired or the size of the reel involved. The reel end of the chain is attached by clipping it under the nut of one of the stay bolts.

To the end of the arbor is welded a short stub of salvaged 2½-inch tubing, the latter being the extension to which air tongs are attached in turning the reel. Flanges welded to the arbor prevent lateral shifting. Such a device saves considerable time and labor and, since the tubing tongs can be throttled down to any desired speed, wire rope can be pulled on just as fast as required in order to spool it properly.

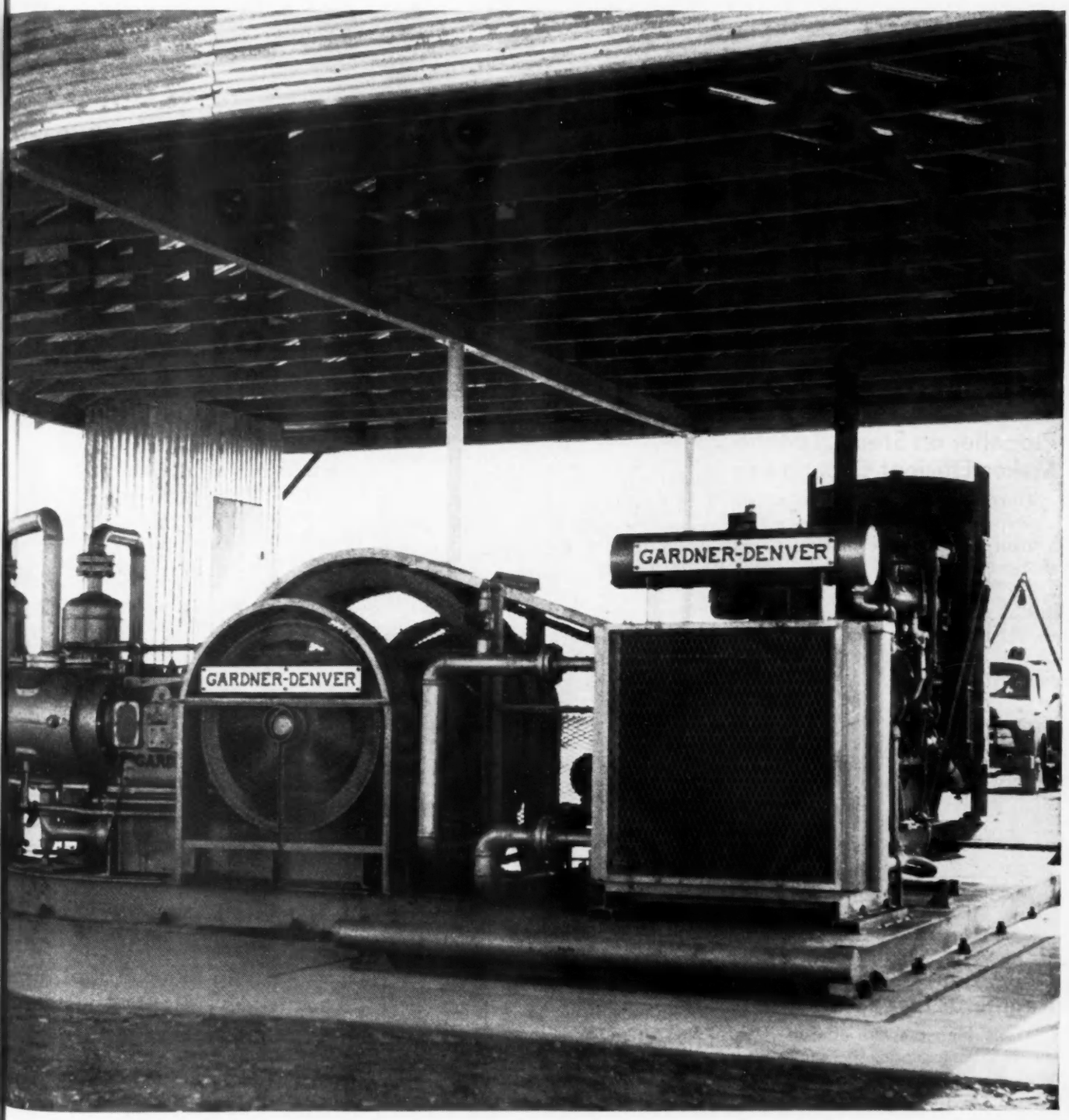


Gravel, Planks Economical Base for Pumping Unit

When a pumping unit is installed temporarily, as during a line-drive flood, a firm, economical base can be provided as shown.

A bed of medium sized gravel is laid, to the height necessary for the

FOR YOUR ENGINEERED COMPRESSOR PACKAGE



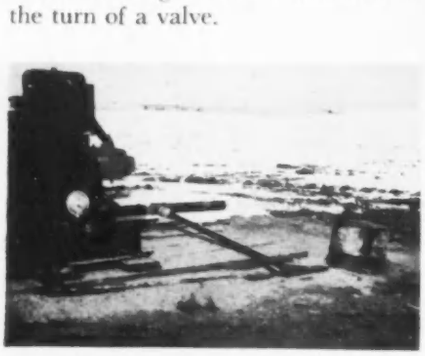
horsehead to clear the wellhead, and levelled. The gravel bed is then covered with 3 x 12-inch planking, laid parallel to the unit base, which is as long or longer than the unit base. Planks as wide or wider than the unit base are then laid perpendicular to the unit base on 24-inch centers, except that two planks are laid side to side at the forward end of the unit. The unit is then set in place with no tie-downs necessary.

The unit shown, a 320,000-inch-pound, 100-inch stroke air balance, pumps approximately 600 barrels per day from 5,600 feet and has not shifted nor rocked in 5 months of service during extremely wet weather.

Propeller on Steam Turbine Makes Efficient Cooling Fan

To cool one of the sheds on his rig, a toolpusher mounted a propeller to a small steam turbine making a very efficient fan.

This fan is fixed to a substantial mount and then fixed to the side of the shed. By piping steam to the turbine a cooling breeze is available at the turn of a valve.



Half-Drum Will Prevent Regulator Freeze-Up

When high pressure casing-head gas is used to operate pumping unit engines and the pressure regulator freezes, the freezing can be prevented by placing a half-drum over the regulator and bringing a 2-inch line off the exhaust and into the drum.

Several holes punched or cut in the top of the drum provide relief for the exhaust gases. The hot exhaust gas is very effective in the prevention of pressure regulator freezing.

Rig Identification Lights For Workers Convenience

An operator in the Gulf Coast has installed identifying lights on his rig so that service engineers, truck drivers, and others can readily find his rig whether it be night or day. The lights are mounted on a board and arranged to spell the initials of the operator. They are colored to make them easier to see in the daytime when the electricity is turned off.

The sign board is mounted at an easily accessible height on the derrick to facilitate bulb changing, but high enough to be easily seen from the road.

FIGURE 1

Adjustable Platform Is Excellent Derrick Floor

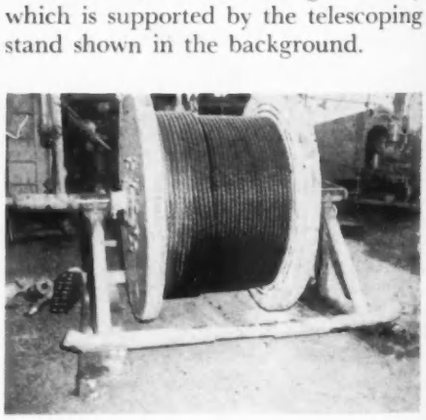
When a well servicing contractor starts to pull a well, many times the operator will not know if he will go ahead and work the well over until after he has inspected the tubing and bottom-hole pump. One Gulf Coast contractor carries all of the equipment ready for a complete workover on all jobs from a rod pulling job to a complete workover.

FIGURE 2

On the front of the mast, he has welded a set of two pieces of slotted 2-inch pipe with holes and pins to which the platform can be attached and adjusted to its proper height. A walk folds out between the pipe racks to facilitate racking. A set of saddles was then welded to the back of the mast so that the blowout preventers could be swung up and carried for use on the next location.

Figure 1 is a view of the back of the mast showing the slotted runners to which the platform is attached and the saddle for carrying blowout preventers.

Figure 2 is a view of the derrick floor which shows how it fastens to the mast and the folding walkway which is supported by the telescoping stand shown in the background.



Telescoping Skids Adapt Rack to Any Sized Reel

Adapting the shop-made, skid-mounted rack to accommodate a reel of any width, one contracter cut the skids at the mid-point and made tele-

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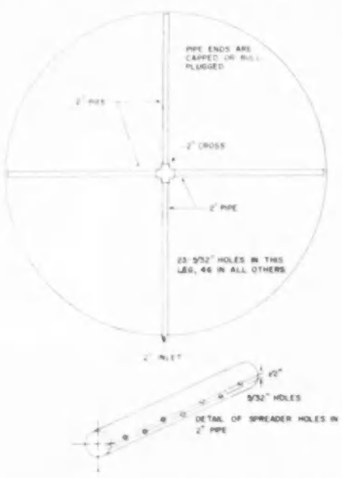
DIAMOND BITS DIAMOND CORING
WELL LOGGING CORE ANALYSIS

scoping joints which can be adjusted as necessary merely by turning several set screws.

The skids on the unit illustrated are of 4½-inch drill pipe, with the inner telescoping section being of 3½-inch material. A heavy set screw at either side of the split prevents slipping of the joint once the reel is mounted and centered on the arbor.

Collars, with the inner flange having a convex surface to more snugly fit the arbor hole, are slipped over the arbor and locked in place with set screws. The telescoping feature provides a flexibility of handling that can save its cost many times over.


PIPE ENDS ARE CAPPED OR BULL PLUGGED
2" PIPE
2" CROSS
2" PIPE
23 5/32" HOLES IN THIS LEG, 46 IN ALL OTHERS
2" INLET
5/32" HOLES
DETAIL OF SPREADER HOLES IN 2" PIPE

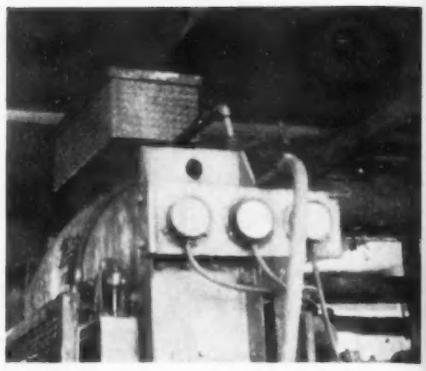
Spreader System Prevents Sediment Accumulation

The drawing illustrates a spreader system which is installed in the bottom of stock tanks to prevent the accumulation of paraffin and other sediment. It has been found that operation is most successful when the oil is brought in through the side of the tank, rather than the top.

The 2-inch pipes are laid on the bottom of the tank. Holddowns are not necessary. The holes are arranged so that the fluid flow in the tank is in one direction, that is, clockwise or counter-clockwise.

The $\frac{5}{32}$-inch holes are arranged in the two staggered rows, one on the horizontal axis, the other one-half inch below. The holes must be drilled, since if they are burned, too much area results. The 161 holes specified on the drawing have a total area equal to that of a 2-inch pipe, thus assuring uniform flow through the holes.

The heat action of the fluid leaving the holes imparts a circular motion to the fluid, thereby continually rolling the tank. Tanks equipped with this type of spreader have been in service for four years without the occurrence of high bottoms or the necessity of cleaning.

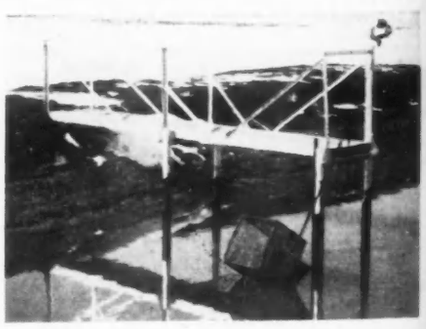


Reservoir for Radiator Serves Twofold Purpose

This reservoir for the rig motor radiator serves a twofold purpose. Not only does it supply an extra volume of water, but it also makes it very easy to inspect the amount of water that is in each radiator.

In West Texas, where this rig was located, the high summer temperature makes it necessary to provide extra cooling for the rig motors. This rectangular reservoir does the job. It is easily constructed from scrap sheet metal and is fitted with an opening in the bottom which forms a water tight connection with the radiator opening. A lid keeps dirt and foreign material from getting into the radiator.

For convenience, rig water can be tapped into this reservoir.



Heavy Screen Prevents Pump Suction-Line Fouling

A pump suction-line which is subject to fouling by weeds or other debris can be protected as pictured.

The heavy screen covers a framework which is welded to the pipe. The 8-inch pipe shown projects approxi-

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..1956.. FIRST MAGNETIC CAGE CHECK VALVE

The HB Magnetic Cage Check Valve for gas lift valves eliminates the use of springs, rubber, or other short-lived materials in the highly critical check valve operation of the gas lift valve. As the check valve cage has no springs to cause mechanical vibration, your gas lift valve's operational life is usually greatly extended.

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The HB Magnetic Trip eliminates all high pressure movable seals in the plunger lubricator. You benefit from trouble-free lubricator operation and longer life for both wellhead equipment and plunger.

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The HB "VSB" Plunger has spring loaded hard chrome plated wobble washers that positively ride against the tubing wall and effectively remove paraffin without danger of hanging in the well. An automatic, monel trimmed, bypass valve allows faster falling of the plunger.

1958 FIRST LOW COST, ABSOLUTE, FIXED SERVICE AND REPAIR PROGRAM OFFER ON GAS LIFT VALVES

The HB gas lift valve is warranted one year against any mechanical defect. Repair and/or exchange costs of gas lift valves and check valves *based on time in service.*

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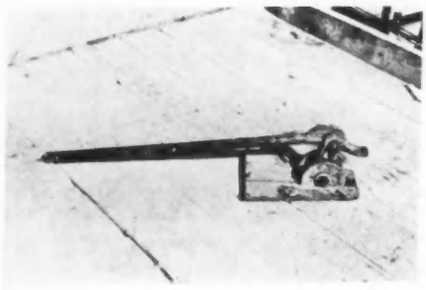
mately 10 feet from a permanently submerged ell which was left loosely made up so that the guard could be raised out of the water for cleaning. The pipe and guard are raised with a small hand-operated winch and fall of their own weight when the winch is reversed.

During construction, it must be ascertained that the weight of the pipe is sufficient to overcome the friction of the threads in the ell. To prevent any possibility of the winch-line slipping on the pipe, the line is clamped to a short length of chain which is welded to the pipe.



Improve Drilling Efficiency By Stacking Pipe Neatly

When racking drill pipe in the derrick it is seldom racked properly in a row. In this case most roughnecks use chain tongs to properly align the stands. However, this practice could very easily damage the shoulders of the pin end.

This device is built out of an iron bar or some scrap material usually found around a rig. The bar is connected through a bolt to two pieces of flat iron which, in turn, is bolted to the ground plate.

An apparatus of this nature will improve the efficiency and safety on a drilling rig.

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You'll win more than this prize. You'll increase drilling efficiency and control your mud better. Mud-O-Graf records every variation in mud weight, saving time and costly errors in the addition of weighting materials. All heavy and light streaks in the circulating system and their duration are recorded. Mud-O-Graf shows how often the hole is filled up when coming out of the hole and shows the time of a complete circulation. If it's a question of mud, ask for Mud-O-Graf.

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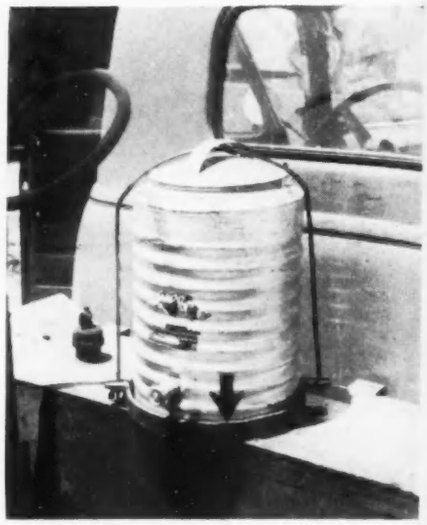


U-Shaped Bar Holds, Protects Water Can

The perennial problem of having the water can and/or the lid fly off or tumble over while travelling over rough lease roads, is solved efficiently by the production department of one company.

To the steel ring base in which the can rests in the back of the pick-up truck is welded a pair of slotted ears, as shown. A length of ¼-inch round bar, threaded on one end and equipped with a nut or hook on the other, is bent into a U-shape and looped over the can and through the handle of the lid. Fitted into the slots, the bar is tightened at the threaded end with a wing nut. Releasing the can for filling requires but a few turns of the wing nut to release the hold-down.

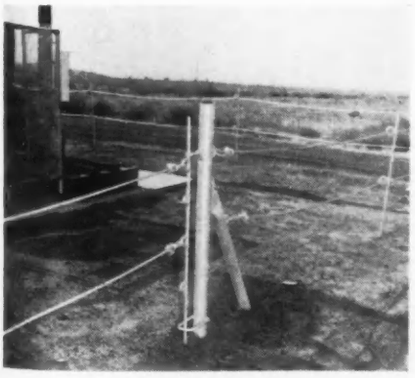
The device will pay for itself many times over in prolonged life of the can due to reduced scuffing of the bottom, denting of the can, or loss of the lid.

Build a Hand Brake To Control Reel Speed

A small, easily detachable hand brake used for slowing down the rotation speed of the reel when rope is being pulled off can be built of salvaged materials. Adaptable to most field units, the brake replaces the often-used make-shift method in which a plank or timber is pressed tightly against the reel.

In the installation shown, the shoe is made by cutting a one-third section from a 6-inch length of pipe, the latter having an inside diameter about equal to the ouside diameter of the arbor. The arbor is attached by chain or other linkage to the real so both turn as a unit. The 2-foot handle, having a V-notch cut in one end, is hooked under an eye burned in a bracket welded to the saddle supporting the arbor.

With the considerable leverage supplied by this hand brake, rotation of the heavy reel easily is controlled as desired. When not needed, the handle and the attached shoe can be removed and stored in the tool box.

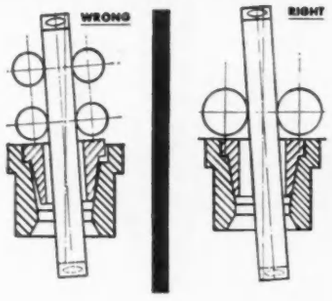


Sand Line and Simple Gate Reduce Well Enclosure Cost

An inexpensive well enclosure which can be installed quickly and with a minimum of welding or setting of posts, is shown in the accompanying photograph. Salvaged sand line is strung between the four corner posts and the gate post. Supports at midpoints consist of "posts" of sucker rod, the lines being run through eyes welded to them. Drawn up tightly, the sand line is sufficiently taut to withstand nudging by livestock; the sucker rod posts merely reducing the amount of sag that otherwise might occur at those points.

The gate, also of sand line, is latched in much the same way as the conventional cattle gate seen in any farmer's yard. The removable post, a length of sucker rod to which the gate lines are attached, is drawn up and latched behind a hook welded to the fixed post.

One of the advantages of this type of fence, aside from its initial low cost, is the fact that should a well have to be re-worked, requiring that the enclosure be taken down, removal of a few cable clamps permits dropping the entire fence and pulling it to one side.



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The platform pictured is used for elevated work on heater-treaters or other equipment which has flanged manholes.

The loop is hung over the manhole, behind the flange, and the platform is held steady by the angle-iron braces which project from the bottom corners. The platform may be handled with gin poles or block and tackle.

This type of platform is less costly, easier and quicker to put in place, and safer to use than scaffolding. The platform shown was constructed from 1¼-inch sheet, and ⅝-inch sucker rods, all salvaged. It is bolted together except for the sucker rod hanger, which is welded. The platform is 4-feet square and the safety rails are 4-feet high.

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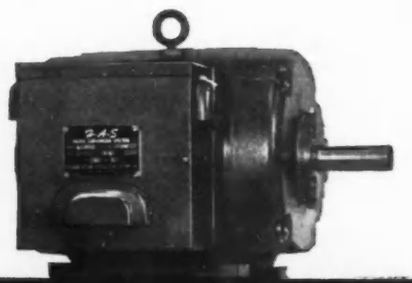
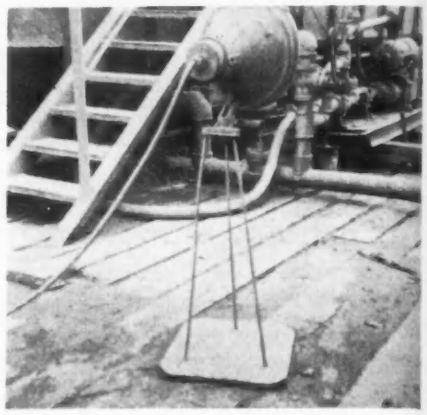


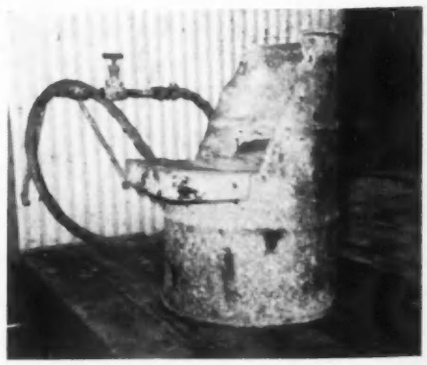
H-A-S PHASE CONVERSION SYSTEM



Construct Simple Stand For Portable Rig Light

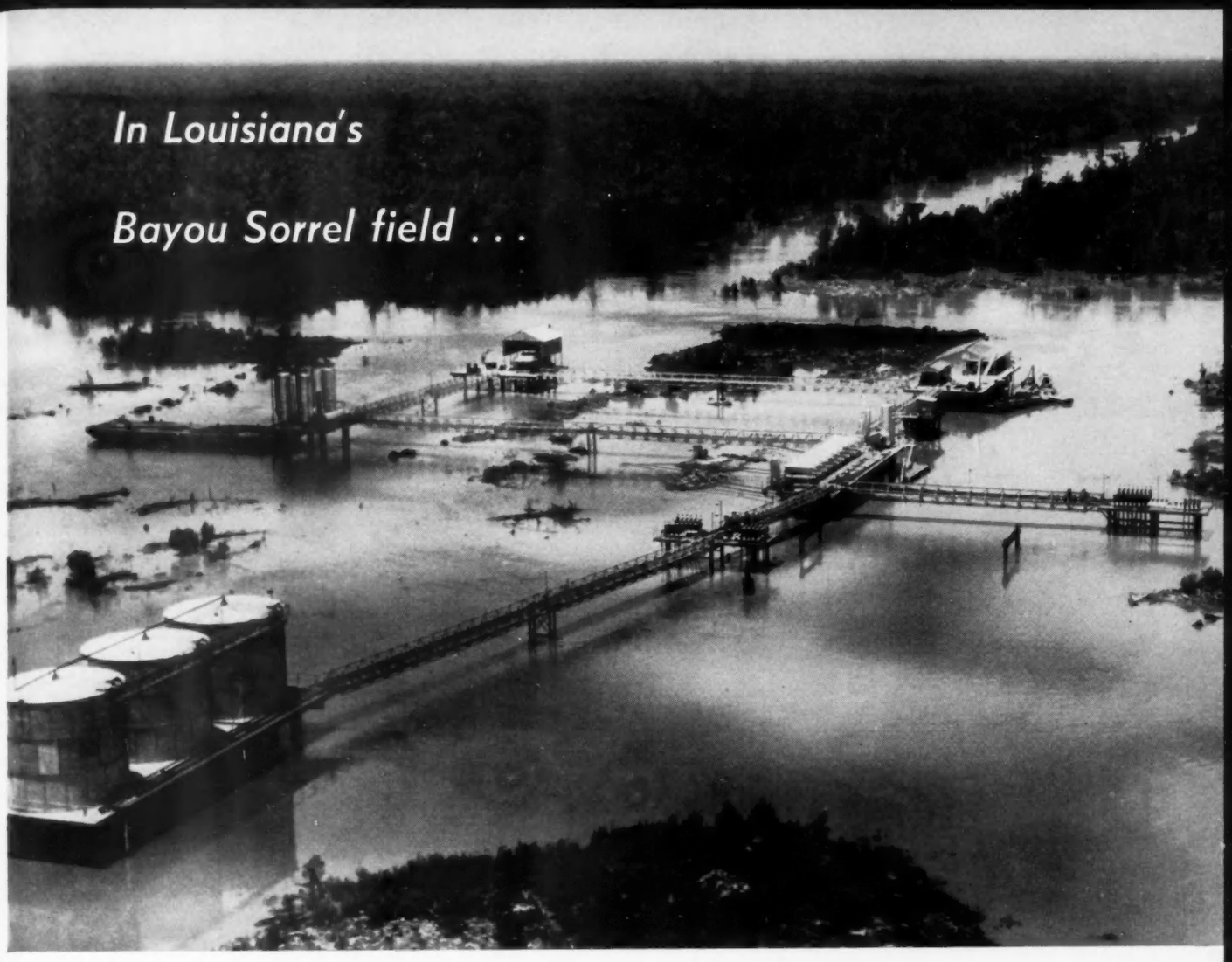
A simple stand on which to mount a portable rig light can be made from three lengths of small diameter rod and a large and small piece of sheet metal. The large piece of sheet metal forms the base of the stand, the three pieces of rod form the tripod legs and the small piece of sheet metal forms the top of the stand on which the light is mounted.

This light-stand combination can be moved to any place around the rig where extra light is needed for repairs.



Make Comfortable Rig Chair From Discarded Oil Drum

A comfortable rig chair that isn't afraid of the elements can be easily constructed from a discarded oil drum and a piece of bard. The oil drum is cut on a diagonal from the middle of the drum to the top. The board is cut in a suitable shape and placed in the opening, forming a seat.



The first automatic well-test installation using a punched tape data recording unit was installed in the Bayou Sorrell field of Louisiana.

Shell develops unique data recorder for automatic well testing

By Claude A. Sellars, Jr., Engineer
Shell Oil Company, New Orleans

A MACHINE-SENSIBLE analog multichannel data recorder is being used by Shell Oil Company for recording of well test data. With suitable readout apparatus, the method presents well performance data in any desired format, including tabular totals, graphical representation of one or more of the recorded variables as a function of any other recorded variable and machine computed information. Performance data presented in this manner allow for more thorough analysis of well producing characteristics. The recording system also provides a permanent record of all events occurring during each test and any test can be "recreated" at a later date if desired.

MECHANICS OF WELL TESTING AND DATA ACCUMULATION

The first automatic well-test installation using a punched tape data recording unit was installed in Bayou Sorrel field, Louisiana, in December 1957. This field was chosen for the initial installation for several reasons. First, it is a remote swampland ma-

FIGURE 1—This is the programer control panel and tape punch equipment used in the automatic well testing system at Bayou Sorrel. Note the interior wiring of the choke-identification switches.

rine field subject to heavy fog, rain and general high-humidity conditions. Second, field producing facilities were being rebuilt which allowed necessary diverter valves to be installed when rebuilding the central facilities. Also, the layout of the facilities included installation of all well manifolds at a central site, thus eliminating costly remote-control cables.

Bayou Sorrel field is subdivided into several production units and leases. Flow lines from each of the field's 35 wells terminate in headers located on one of two manifold platforms. A bulk or production line from each header routes production to the proper unit or lease two-stage separator for separation and metering prior to commingling in common tankage. A single test line from each manifold platform routes test production to a two-stage test separator identical in all respects to the production separators.

Individual well diversion is by three-way, two-position, 2,000 psi motor valves. Operating gas for each

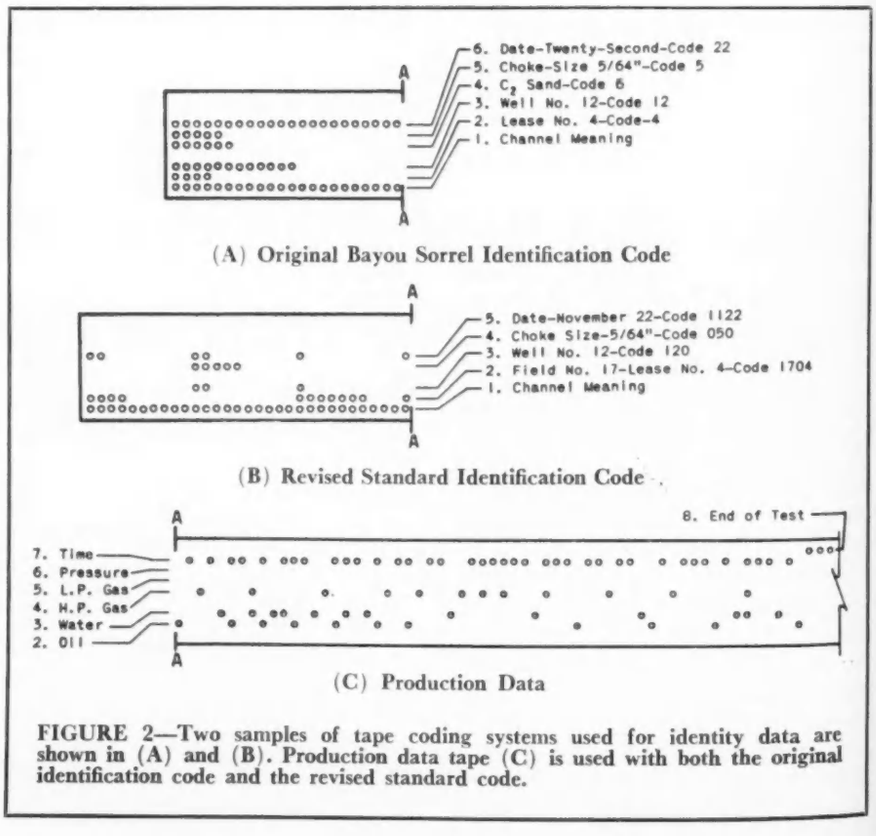


FIGURE 2—Two samples of tape coding systems used for identity data are shown in (A) and (B). Production data tape (C) is used with both the original identification code and the revised standard code.

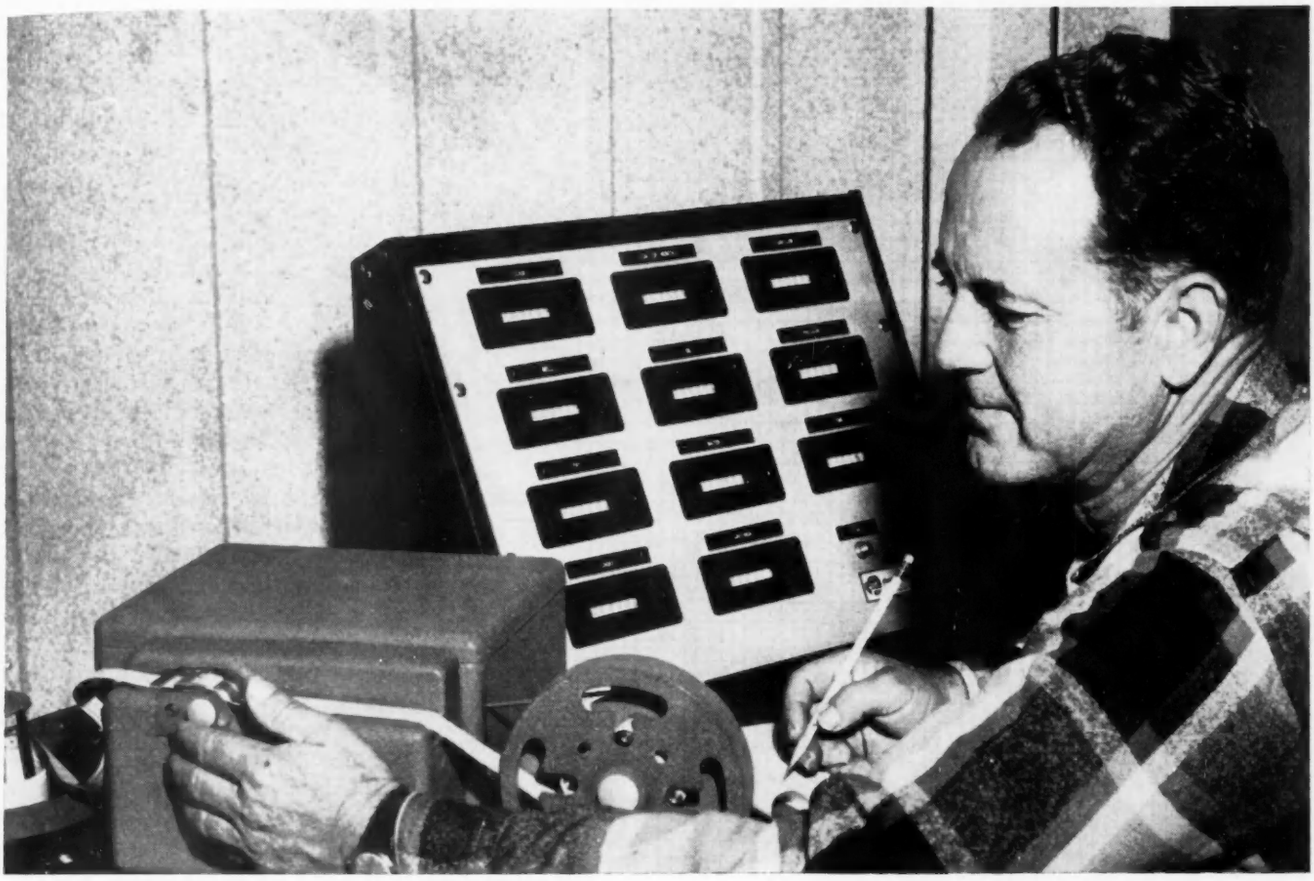


FIGURE 3—A standard 8-channel tape reader and counter panel are used to process tape from the data recorder. More elaborate processing machines are in the planning stage.

of these valves is applied by a solenoid valve controlled by the test programer.

Instrumentation. Oil production is determined by a 1-barrel volume meter. A pressure switch installed in the control of this meter is actuated while the outlet valve of the meter is open, thus giving a switch closure for each barrel measured.

Water from wet wells is measured by an impeller-type meter equipped with a cam-operated switch mechanism which provides a closure for each barrel count.

Gas is measured by a flow computer equipped with a pulse switch giving one closure for each five-count increase in meter reading.

Programer. The programer is composed of two basic groups, the well-selector and the identification section (Figure 1). The well selector is a standard stepping switch which steps upon completion of each test and in fixed order sequentially selects wells to be tested. A bypass switch is provided for each well so it may be removed from the system and skipped during the test cycle.

One test duration timing system is provided which is adjustable for time periods varying from 6 minutes to 40 hours in 1/10-hour increments. Each well is tested for the time period manually set on this timer. In view of the analog-type data-recording method used, the need for separate test-duration time periods for each well was not necessary. A purge timer also is included to allow purging of test equipment between tests.

The identification section operates in conjunction with the well-selector section to feed proper identification data to the tape punch at the beginning of each test. Again standard stepping switches and plug-in relays are used throughout to reduce overall cost and permit servicing by non-technical personnel.

Cost of test programers varies with the number of wells tested, amount of identification data desired and type of enclosure required. However, an average unit serving 30 to 50 wells will cost about $4,000-$5,000.

Data-recording unit. The tape punch is a standard 8-channel unit which may be brought "off the shelf" as a stock item for approximately $700. The pulse-limiting network is necessary to prevent erroneous punching.

The several test instruments indicate quantative values in the form of unit-value switch closures. Each switch closure, although lasting several seconds, must be represented as only one punch on the tape.

The tape punch has a normal operating rate of 20 punches per second. Without pulse-limiting components, a 3-second signal pulse would cause 60 punches rather than 1 to be punched. This is prevented on the inital unit by using fast acting (20 milli-sec) relays connected so that only the first milli-sec of any pulse is permitted to reach the tape punch unit. The relay then electrically locks in an open position

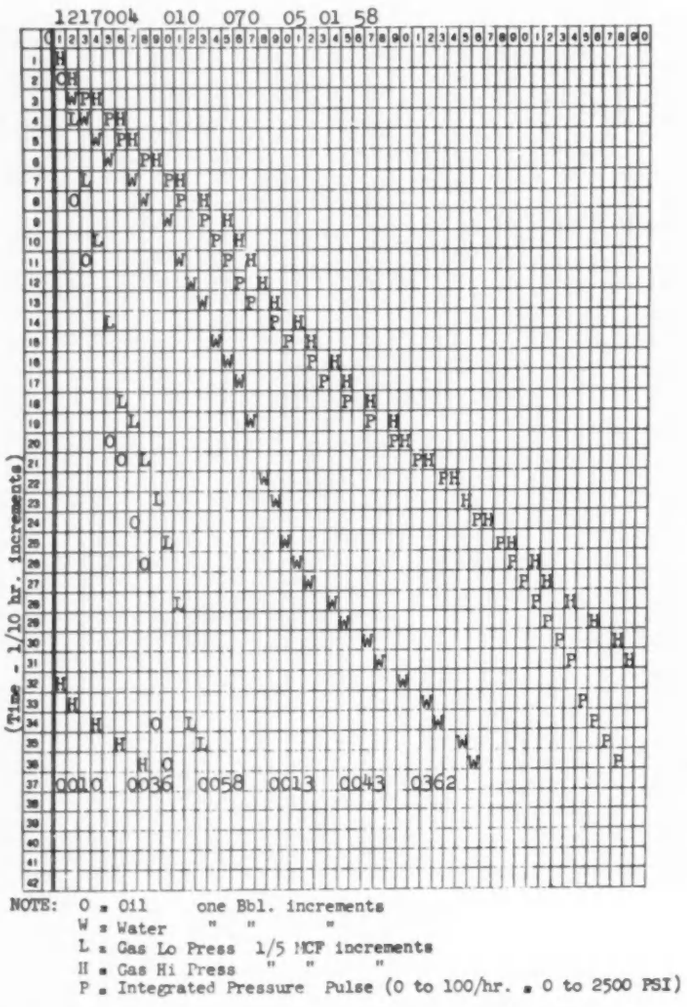

1217004 010 070 05 01 58
(Time - 1/10 hr. increments)
0010 0036 0058 0013 0043 0362
NOTE: O = Oil one Bbl. increments
W = Water " "
L = Gas Lo Press 1/5 MCF increments
H = Gas Hi Press " "
P = Integrated Pressure Pulse (0 to 100/hr. = 0 to 2500 PSI)

FIGURE 4—Here is a proposed test print-out which will result from processing data through a master reader.

until removed; it then returns to its normal position ready to "clip" the next pulse.

This method of controlling duration of pulses received by the tape punch requires critical timing of relay operation and is not 100 percent foolproof because of the mechanical lockout feature of the punch. Pulses may be lost if punching operations are in progress when an additional pulse is received. Shell engineers have developed a foolproof method of controlling pulses by using the parity check contacts operated by the tape-punching pins to actuate the pulse-limiting relays. This method does not require critical relay timing and causes one and only one hole to be punched for each switch closure.

Tape coding. Well-performance data and identify data from the programer identification section are recorded on an 8-channel tape (Figure 2).

The original Bayou Sorrel identification code system used channels 2-6, respectively, to identify lease, well, pay (sand), choke size and day of month for each well tested. Since a standard 51-point stepping switch was used, a limit of 51 holes could be punched in any one channel for identification purposes. The system punched in each channel, the number of holes equal to the identifying or code number for the particular information recorded. Using Figure 2 as an example, if a particular well is in lease No. 4 (the lease number is the last digit of the accounting lease code number), 4 holes will be punched in Channel 2. Similarly, if the well is No. 12, 12 holes will be punched in Channel 3. If the test was begun on the twenty second day of the month, 22 holes would be punched on Channel 6. The number of holes punched in Channel 5 is the numerator of the "64ths" fraction signifying choke size. Choke sizes are "read-in" to the identification section of the programer through a pair of rotary switches for each well. These switches are set manually by the lease operator.

Although the original system was simple and required only a tape reader with a counter for each channel to accumulate data stored on the tape, it was not practical for the recording of large numbers. Since the system records a number by punching a like number of holes, and the tape punch operates at a speed of 20 punches per second, 7.5 seconds would be required to punch the 150 holes necessary to record the number 150. Only 10 holes can be punched per inch of tape, thus the number 150 would require 15 inches of tape. To reduce the time and amount of tape required to record large numbers, the identification system was revised. The revised method utilizes a maximum of 50 punches per channel to record any 5-digit number up to 99,999 per channel or a total of 30 digits in the six available channels.

This second coding method breaks the desired number into individual digits and punches a number of holes equal to each digit (0-9) in a series of 5 groups of 10 "punch-space" combinations. The right-hand digit of each numer is punched first and each successive 10-group series identifies successive digits to the left. By dividing the 51-point switch into 5 sections of 10 points each, it is possible to multiple its per channel capacity by 2,000. No additional equipment was required in the identification section to change to the new coding system. Figures 2A and 2B compare tapes for equivalent well identification using the two coding methods. Figure 2c shows the method of recording performance data. A unit-event punch system is represented in both cases.

Several changes in recorded information have been made possible by the new code (Figure 2). First, the lease-channel data now include four digits. They include the last two digits of the accounting code for the field and for the lease. Second, an additional digit has been included to the right of the well number to indicate type of completion (from standard accounting code—0 for single completion, 1 for dual completion, or 2 for triple completion). Pay (sand) identification has been excluded as unnecessary. An additional digit has

been added to the right of the choke digits to signify intermediate sizes used when very small chokes are used to control flow. Also, the date channel has been expanded to four digits to include month and day of month. At present, only 14 of the possible 30 digits are being used, which leaves a reserve of 16 additional digits to be used as required to identify such items as meter factors, selected test time, lease operator, etc.

DATA-PROCESSING METHODS

The data recording system achieves its exceptional value from two features: data are recorded on a machine-sensible media and test-performance data are recorded chronologically so that each recorded variable, including time, is in correct relationship to each other variable.

The terminology "machine-sensible media" covers a multitude of methods including punched tape or card, magnetic tape or wire, film, etc. Standard recording media for most automatic well-testing systems are either counters or a multi-pen strip chart operations recorder. Neither is machine sensible. In each case data which appear on the storage media must be translated manually into a useful form. Another manual operation is required to transpose the data into a machine-sensible form (punched tape or card) for processing by data-handling equipment. These manual operations introduce sources for possible error and increase the expense of translating recorded data into more desirable form.

A system which records data on a machine-sensible media eliminates at least two manual steps prior to introduction into data-processing equipment and reduces the time element from hours to seconds. The tape from the Bayou Sorrel unit can be fed directly into one of several processing machines.

Three basic types of processing machines presently planned for tape readout are a counter system, an "intermediate" and a "master" reader. Only the simple counter system now is in use.

Readout counter system. This machine is composed of a standard 8-channel tape reader and a counter panel (Figure 3). Tape from the data recorder is fed into the tape reader which antomatically totalizes individual channel counts on a bank of electrically operated counters. An "end-of-test" signal is punched in channel 8 between each set of individual well-test data. The reader stops at the end of each set of test data to permit the operator to record infortion and reset counters before reading the next set of test data. Tape is read at the rate of 1-inch per second so a single reader may serve a considerable number of individual recording units. Identification data are separated from production data by using Channel 1 of the data tape as a "channel-meaning" selecter. A continuous row of holes is punched in channel 1 during the time identification data are being punched in the remaining channels (Figure 2). A multi-pole double throw relay in the counter panel diverts all pulses (exclusive of Channel 1) to a bank of counters for identification totals as long as there are holes in Channel 1. No holes are punched in Channel 1 while recording production data. This lack of holes causes the counter-selector relay to divert all pulses to a second bank of counters for production totals. Thus, the use of a "channel-meaning" code allows dual use of each of the seven remaining channels.

A counter-type reader makes the entire system into a relatively complex version of a simple counter type of data-recording unit. However, this reader was built only to assist in proving the over-all operation of the punched-tape system.

About the Author

Claude A. Sellars, Jr., is a graduate of Rice Institute. He joined Shell Oil Company in 1954 as a junior mechanical engineer and after serving in the Tulsa, Midland and New Orleans areas, he was promoted to mechanical engineer in 1955. After serving at Shell's Wood River refinery in Illinois for a short period, he was transferred to his present position as mechanical engineer at Donaldsonville, La., in 1957.

Intermediate reader. A planned intermediate reader would be composed of an 8-channel tape reader and electric typewriter with associated data-handling controls. This reader, unlike the counter system, can take full advantage of the chronological data recording feature of the punched-tape system. Other well-test data recorders either record only a total test figure or record as a function of time on a strip chart. This latter method is of limited practical benefit because of the time and effort required to transpose chart movement into time or relationship of one variable to another.

By using an electric typewriter and readout-type counters, tape channel totals can be typed and a curve can be plotted for any one of the several production variables with respect to any other variable. This is accomplished for oil production by directing each oil pulse to a given key solenoid (say O for oil) and directing each time pulse to the line advance solenoid. Using this method, a plot of oil vs. time can be obtained. By use of a selector switch and successive tape reruns, rate curves can be plotted for each of the variables or another variable other than time may be used to give a plot of oil vs. gas or high-pressure gas vs. low-pressure gas, etc.

The ability to mechanically plot production curves is an attractive feature of the system. These curves can be used by field supervisors and engineering personnel to more fully understand individual well characteristics. Special tests can be run to graphically illustrate effects of various choke sizes, gas-injection rates, effects of temporary or prolonged shut-in periods, etc.

With proper readout circuit controls this intermediate reader could be combined with a 5-channel tape punch to prepare coded teletype tape for transmission to a remotely located master reader for further processing and storage.

Master reader. Development of a master reader has been dependent on the reliability of field programers and data recorders. Since the initial unit has proved successful, a master reader now is being planned. This unit is basically similar to the intermediate reader with two exceptions. First, more complex controls will be provided to permit simultaneous plotting of all rate curves by an electric type-

writer. As the reader and pulse counters read the tape, totalized recorded data will be typed out and may provide simple computations such as 24-hour rates, average pressure, etc. Second, data to be stored for later reference will be transferred to coded tape or punched cards. As with the intermediate reader, identification data and production totals will be typed for each test. The cost of a reader also depends upon results desired. The master reader discussed here will cost about $10,000. Figure 4 shows a typical test "print-out."

FACTORS DETERMINING SELECTION OF READERS

Reader systems used should be evaluated for each locale. The three types of readers discussed previously (counter, intermediate and master) are increasingly complex and expensive in that order. From an economic and operational viewpoint it is desirable to make field-test units as simple as possible. The relatively few readers then may be made more complex if necessary.

As an example, fixed data recorded by the field unit should be kept to a minimum for the sake of economy and simplicity. An almost unlimited amount of data concerning each well can be obtained from storage units by the master reader if additional information is desired. One complex reader serving many simple field-test units would be more economical and easier to maintain than a simple reader serving many complex field-test units.

Present practice requires the lease operator to tabulate well-test data at the field level. With the proposed system, this would require a tape reader for each field office for translation of accumulated data and completion of required tabulations. A more efficient method of tabulating data would result in transfer of the original test tape to a central point for processing and distribution as necessary. All interested supervisory and engineering personnel then could receive tabulated test results.

There are many combinations of data-processing, transmission and storage systems possible. The only limit to the capability of the punched tape data recording system is an economic one, for in each locale the operational system must be fitted to its economic value.

A unique feature of this installation is the method of obtaining a controlled frequency signal for time measurement. Electric power is obtained from loosely regulated 30 kw gas engine driven generators. Output frequency varies so widely it is useless for even short-duration (4-8 hour) timing. All timers are powered by a rotary converter with 12-volt DC input and 115-volt AC input battery charger. This system provides suitably stable frequency but requires occasional converter adjustment and battery servicing.

ADDITIONAL INSTALLATIONS

White Castle field. An improved test unit for testing 50 wells now is being set up in the White Castle field. This programer presented several interesting switching problems. Tests will be made at three different block stations, each equipped with a test heater-treater or test separator with oil, water and gas meters. Meter types are the same as those used on the Bayou Sorrel unit. Aside from well selection, data pulses from each block station must be segregated.

One of the three block stations servicing 17 wells is located approximately 3,000 feet from the programer. Rather than install an expensive remote-control cable to switch these wells and transmit data pulses, a simple 25-programer section designed to follow the main programer will be installed at this block station to switch wells in the proper sequence. Control for this slave unit as well as data-pulse transmission is by inexpensive direct-burial cable.

South Pass Block 24 field. Three automatic well-test units are presently being installed in the Block 24 field. Each is a complete unit located on an offshore production platform. When placed in operation, the units will perform a preset series of tests each month.

The units are similar in operation to those discussed previously except that a multi-service clock and individual well-selector switches are used to set up different test durations for each well. Tapes from each unit will be picked up periodically and processed by a combination intermediate and master reader in the field office. Present plans call for a tape reader, an electric typewriter and a 5-channel tape punch with controls to plot all production curves simultaneously, and punch a 5-channel tape to be used to transmit an identical plot by teletype to another production office.

Experience with the Bayou Sorrel automatic well-test unit has shown it to be a reliable and accurate method of obtaining test data. The uses for this data present many opportunities for new and improved methods of data processing, transmission and storage.

This article is based on a paper entitled "A Machine-Sensible Analog Data Recorder for Automatic Well Testing" presented to the 1959 Spring Meeting of the API Southern District, Division of Production at New Orleans. —**The End**

SUCCESS OF a facsimile network spanning about 150 miles for transmitting well logs *via telegraph in photo form* in the Rocky Mountain area presages similar use of radio to provide immediate transmission of well logs from drillsite to office. A group of companies operating in the U.S. Gulf is planning to transmit electrical logs from offshore wells, using specialized facsimile transmitting and receiving equipment, via microwave. When such systems are in more widespread use, saving of much rig time and elimination of considerable inconvenience to wellsite and supervisory exploration personnel is expected to result. No longer should it be necessary to shut down a rig and crew awaiting orders from a district or division office whether to set pipe or plug the hole or whether to drill stem test or core deeper, etc.

New discoveries spur interest in Wyoming's Green River Basin

By **Tom Dougherty,** Denver

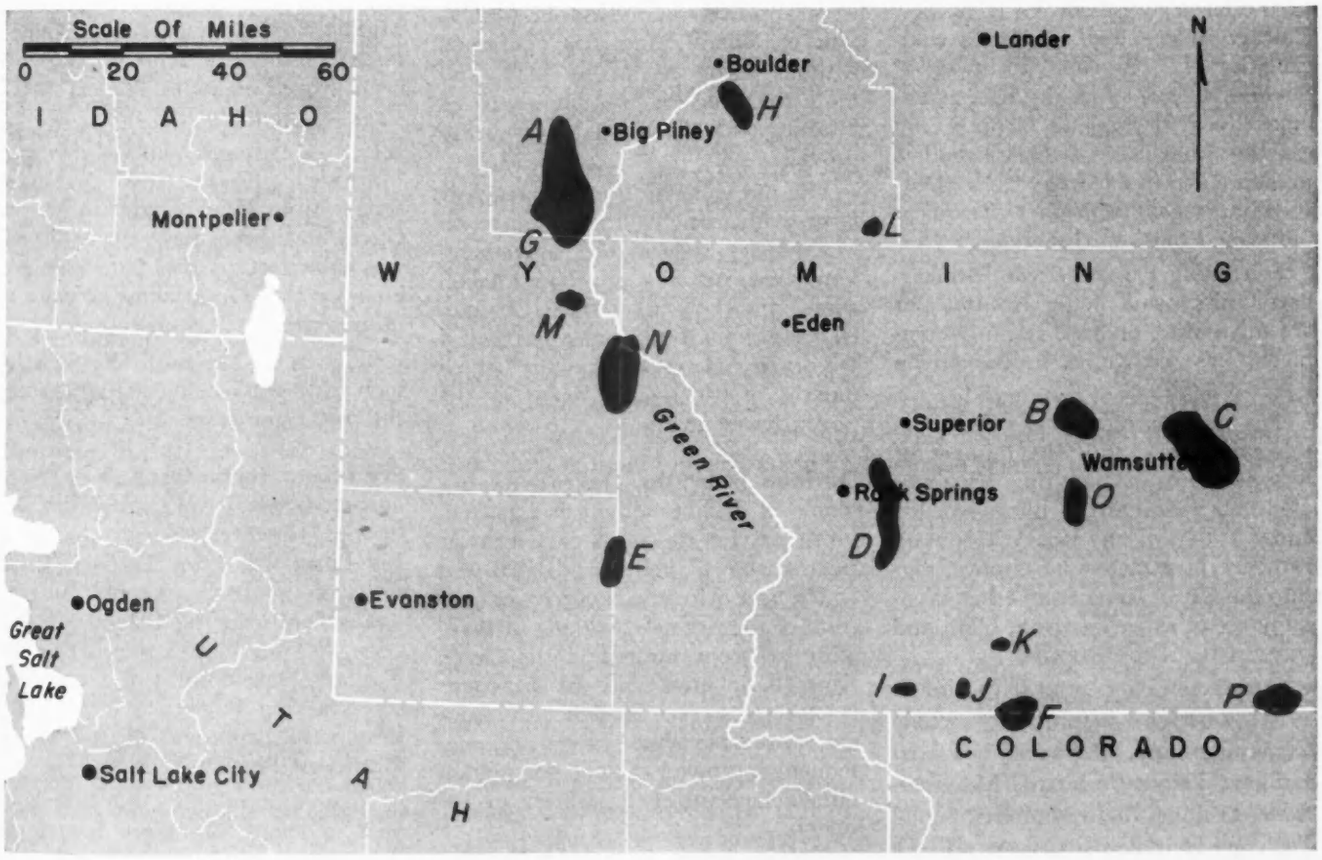
WYOMING'S GREEN RIVER BASIN is rapidly emerging as one of the most promising gas areas in the Rocky Mountain region. Situated in the southwest corner of the state, this major geologic province within the past several months has been the scene of numerous important gas discoveries that include new fields as well as major step-outs and new zones in existing shallower fields.

Boxscore for the area during the first five months of 1959:

- 18 wildcat completions, including nine in Sweetwater County, six in Sublette and three in Lincoln.
- 5 new gas discoveries, including Belfer Natural Gas 2 Unit, Opal Unit, Lincoln County; Pan American Petroleum 1 Unit, Green River Bend Unit; St. Louis Car Co., 1 Govt., Green River Bluffs; G. L. Reasor, 1 Govt.-Reasor, Pacific Creek Unit (proposed), Sublette County; Forest Oil, 1 Unit, Arch Unit, Sweetwater County.
- 21 development wells, with the Big Piney field showing the greatest activity with nine completions.

At mid-April, a list of pending units showed 11 in Sweetwater County, five

Most active areas in the Green River Basin . . .



Symbols identify the most active areas in the Green River Basin. Included are: A—Big Piney Complex; B—Desert Springs; C—Wamsutter; D—Baxter Basin; E—Church Bettes field; F—Hiawatha field; G—Hogsback area; H—Pinedale anticline; I—Middle Mountain; J—Canyon Creek; K—Trail Unit; L—G. L. Reasor gas wildcat; M—Willow Creek; N—Emigrant Springs; O—Table Rock; P—South Baggs.

What's Happening in Green River Basin . . .

- **Activity during the first five months of 1959: 18 wildcat completions —5 gas discoveries—21 development wells. Increased activity is expected for at least five years.**
- **About 20, or one-third of the rigs working in Wyoming, are concentrated in the Green River area.**
- **New production is being found at 10,000-15,000 feet, from Mesaverde and Frontier formations.**
- **Drilling prices range from $5 to $15, depending on the area.**
- **Dual completions and separate pool drilling programs are common in the basin.**

in Sublette, one in Lincoln, and one in Carbon. Of these 18 units, several have since been approved, but most still await approval.

During 1958, the area had 11 gas discoveries including six new fields and five new pays within older fields.

Current drilling trends. Recent developments in southwestern Wyoming include new exploration and new discoveries south and east of Desert Springs, as well as additional successes on the Basin's west side. G. L. Reasor, Chicago independent, drilling a wildcat (See "L" on map) northwest of Superior's 20,521 foot dry hole at Pacific Creek in Sublette County, and estimates that it is capable of about 8 million cubic feet per day from Mesaverde at about 9,000 feet. Reasor is unitizing a block in this area.

Forest Oil, Pan American, Brinkerhoff Drilling and Belfer Natural Gas are all testing, or have recently completed gas discoveries in the Green River Basin area.

The number of successes drilled in the early work, plus the number of new programs in the offing, have created an apparent drilling backlog equal to that of any Rocky Mountain province. Contractors have moved rigs into the Green River from other Wyoming areas, as well as from Utah and other parts of the Rockies.

Contractors who now have rigs in southwestern Wyoming include Camay Drilling, Carpenter-Trant Drilling, Falcon-Seaboard, Mountain States Drilling, R. L. Manning, Signal Drilling and Exploration, J. D. Sprecher, Kerr-McGee, Will I. Lewis Drilling, Fitzpatrick Drilling, Roden and McRae, and Morrison Drilling.

Leasing is heavy. The Green River Basin, here considered to include Sweetwater, Sublette, Lincoln, Uinta, and part of Teton and Carbon counties, is largely public domain. Leasing has been heavy in this area since 1951. Most of the current drilling is on federal units, and the accelerated rate of unit development which became noticeable in 1958 was a major indicator of the extent of interest in future activity.

During 1958, more than 24 units were approved in the Basin. Formation of federal units has continued without let-up so far in 1959, and more than six are now known to be awaiting U.S. Geological Survey approval.

The units have been consistently large, with many calling for up to six wells under the original agreement. Unit areas run to more than 130,000 acres, and few are smaller than 20,000 acres. Of 13 units approved in Wyoming during the first three months of 1959, eight were in the Green River area.

Outlook is bright. An increasing tempo of drilling activity is expected, involving, for the most part, heavier rigs capable of going to 10,000 and 15,000 feet. Already, about 20, or one-third of the rigs now working in Wyoming are concentrated in the Green River Basin area, and the rig count is expected to rise. Existence of major gas transmission line systems and consequent improved outlook for market outlets has spurred interest in the region.

Holding bright promise for the area are the improved potentials gained through the use of air and gas as circulation media, oil base type muds and, of prime importance, increasing use of fracturing to boost output of wells capable of producing at much higher rates than those previously completed with conventional methods.

Activity centered in two areas. The area showing greatest activity during 1959 is the Big Piney district (See "A" on map) and the surrounding area on the Basin's west side. The other major area is on the Basin's east side, east of Rawlins. Here two of the principal discoveries of 1958—Wamsutter and Desert Springs—were completed (See "B" and "C" on map). A belt of exploration through western Carbon County is of constantly increasing importance.

Other areas of activity include the north-south Baxter trend east of Rock Springs (See "D" on map). In the Middle Baxter, Frontier production is found at approximately 1,800 feet and Dakota at about 2,500 feet. Both formations have some 700 feet of closure. Morrison production was found in this field in 1946.

South Baxter Basin also produces from Frontier and Dakota at 2,400 and 2,800 feet, respectively. Effective pay sections in this field, like those at Middle Baxter, range from 25 to 35 feet. Considerably more acreage has been proved at South Baxter.

At North Baxter Basin, production is from Morrison, Dakota and Nugget (Jurassic). Formation thickness ranges up to 575 feet thick in Nugget. Gages have been made up to 14 million cubic feet per day, but the proven area for these formations amounts to no more than 1,000 acres.

This trend has been the scene of increasing exploration activity during the past three years.

Producing formations. Key to the current Green River play is the Cretaceous. However, early production at Big Piney was from Tertiary. Other areas of the Basin, notably the Hiawatha field near the Colorado border (See "F" on map), produce from Tertiary. Development of Tertiary reserves at Big Piney was instrumental in securing approval of the Pacific Northwest Pipeline.

New exploration in the overthrust area involving Big Piney has placed primary emphasis on Frontier, although additional Tertiary development has been done and still is in progress. Also, Cretaceous horizons

younger than Frontier have been found to be productive.

After completion of the Pacific Northwest and Colorado Interstate pipelines, activity spread outward from the Big Piney area. Belfer Natural Gas and Belco Petroleum acquired considerable acreage while negotiations for the Pacific Northwest line were in progress. Belfer developed shallow reserves in the area, then turned to deeper drilling. The company found Frontier production, while General Petroleum was successfully testing the same formation at Hogsback (See "G" on map), to the west.

Frontier in the area produces at depths from 6,500 to 9,000 feet. Reservoir pressures are approximately 3,000 psi, and potentials range generally from 2 million to 10 million cubic feet per day.

Pan American, The California Company and others have since drilled successfully to the Frontier in the complex of federal unit now surrounding the old Big Piney field.

El Paso and Continental completed Tertiary producers on the Pinedale anticline (See "H" on map) in Sublette County in 1955, concurrent with much of the Belfer development at Big Piney. Production was found in Ft. Union sand at about 9,425 feet with net pay of about 90 feet under subsurface closure of approximately 1,400 feet. Initial reservoir pressure was about 400 psi, and initial potentials are on the order of about 2 to 4 million cubic feet per day.

Mesaverde shows promise. Spread of exploration to the east in the basin is largely based on Mesaverde prospects. Prior to 1952, this formation was lightly regarded in the Rockies except for the San Juan Basin of northern New Mexico.

Pan American found Mesaverde crude production at Middle Mountain (See "I" on map) in southern Sweetwater County in 1952, producing from about 6,500 feet in a 16-foot effective section of a 200-foot Mesaverde zone.

At the Trail Unit (See "K" on map) in southern Sweetwater County, Mountain Fuel Supply started new drilling in 1958, six years after the first discovery on the unit, and found two new gas pays in as many wells. Mesaverde gas was found at Trail in 1952, flowing 4.25 million cubic feet per day from perforations at 7,530-68 feet.

Mountain Fuel Supply's first 1958 gas well on the Trail unit found a new zone of Mesaverde from 6,870-7,068 feet which produced at the rate of 12,275,000 cubic feet daily. Another well, completed from three sets of perforations between 5,668 and 5,740 feet flowed at the rate of 34.5 million cubic feet of gas per day, while the deeper zone productive in the first 1958 new pay discovery showed a capability of more than 4 million cubic feet per day.

Perhaps this Trail unit activity is the best current illustration of what may happen in Green River Basin Mesaverde exploration. It should be noted that Frontier gas production on the west side of the Basin generally is from depths greater than that for the Mesaverde production so far established, even though Wamsutter and a few others of the more recent successes offset this generalization. Frontier completions generally have been of somewhat lower volume than many of the better Mesaverde completions.

Major gas discoveries. In 1958, two major discoveries were completed in the eastern sector of southwestern Wyoming. Ohio Oil completed a discovery on the Wamsutter Unit in 12-20n-95w. It flowed 7.5 million cubic feet per day from Mesaverde below 9,500 feet. This gage followed a successful sand fracturing treatment.

Later in the year, El Paso Natural Gas completed a discovery at Desert Springs. It flowed 7.8 million cubic feet per day from Mesaverde from perforations totaling 31 feet between 5,887 and 5,920 feet. This gage followed sand fracturing treatment. During drilling, no drillstem test had flowed more than a million cubic feet per day. Another well in a corresponding zone of Mesaverde flowed nearly 18 million cubic feet per day.

The second well at Desert Springs was completed in the Lewis formation, which also is Cretaceous, but younger than the Mesaverde zone in the field discovery. It flowed 12 million cubic feet per day from 20 feet of perforations at 5,083-5,103 feet. Flowing pressures on tests of Desert Springs wells approximated 600 psi, while pressures at Wamsutter were three to four times as high.

Another Desert Springs completion, one mile south of the discovery, flowed nearly 41 million cubic feet per day. This flow was from multiple zones of the Lewis formation between 5,740-60, 5,770-95, and 5,860-70 feet.

The Desert Springs discoveries were followed by another on the proposed Playa Unit, immediately to the west on which Pubco Petroleum was the successful operator. It is likely, according to geologists, that the reservoirs at Desert Springs and Playa are continuous.

Reservoir pressure in the Desert Springs area has not yet been generally disclosed. Production history is not yet sufficient to provide any sizeable accumulation of data.

Spacing patterns set. Recent action of the Wyoming Oil and Gas Conservation Commission defined pools for the Lewis and Almond (Mesaverde) formations at Desert Springs. A spacing pattern of 640 acres per well was established for each of these formations.

As now defined, approximately 32 Lewis wells and 43 Almond wells are provided for at Desert Springs. Future spacing will be contingent on interference tests which have been ordered within one year of commencement of production under the orders now existing.

Air-gas drilling increases potential. In 1957 and 1958, activity in the Green River Basin became the beneficiary of work done in the San Juan Basin. That is, the processes of drilling with air and gas, and the sand fracturing processes which had met with wide success in the San Juan area were adapted to Green River.

This was the beginning of productive completions in substantial numbers in the Basin. Notable is Canyon Creek (See "J" on map), where the discovery well, drilled by conventional methods made only a little more than one million cubic feet of gas per day. However, another well, drilled with air, was completed for more than 10 million cubic feet per day.

Both of the wells were completed from the same zone of the Mesaverde formation. The second was a short extension to the discovery. Air and gas drilling have encountered no major difficulties in the Basin. Some wells have had water problems, and at least one explosion, at Canyon Creek, has resulted from drilling with gas. However, oil base type muds have been found to offset the bentonite difficulties encountered with water base circulation media, and it

is in more general use throughout the area than is air.

Typical drilling program. Following is the case history of a well drilled to 8,650 feet in the Desert Springs area, Sweetwater County. It is typical of wells drilled to similar depths throughout the Basin. If deeper or shallower, predictable variations will result.

The rig used to drill the well was equipped with three 400-horsepower engines, two 18-inch pumps, 4½-inch drill pipe. 13⅜-inch surface casing was set (typically, this is between 600 and 800 feet). In this case, 9-inch hole was cut, reamed to 17 inches. Below pipe, 9-inch bits were used to total depth and 7-inch production string was set. Twenty drill collars were used. In a 4,000 to 6,000 foot hole, 12 to 16 collars would be run.

Standard blowout preventers were used with an average mud weight of 10.7 pounds. Lime base mud was used initially, with a considerable amount of diesel added later. Highest weight during drilling was 12 lbs/gal—viscosity 61, water loss 2cc, Ph 12.5.

Bit weight varied from zero to 45,000 pounds. Initial rotary speed was 120 rpm, dropping to 75-80 rpm for most of the hole, then to 60-65 rpm at 8,000 feet. Operation used 44 nine-inch bits to 8,650 feet.

Most of the Green River wells are completed after fracturing with sand in the Mesaverde or Frontier sands, depending on whether they are on the east or west side of the basin. In most cases, pipe is set through the producing interval and perforated, usually with four shots per foot.

Rig-up time in the basin runs four or five days in summer, five to seven in winter.

Drilling costs vary. Drilling in the area seldom goes to less than 6,000 feet and depths from 10,000-15,000 feet are more common. Although air and gas drilling have proved effective in the area, no great amount of work is now being done with these circulating media.

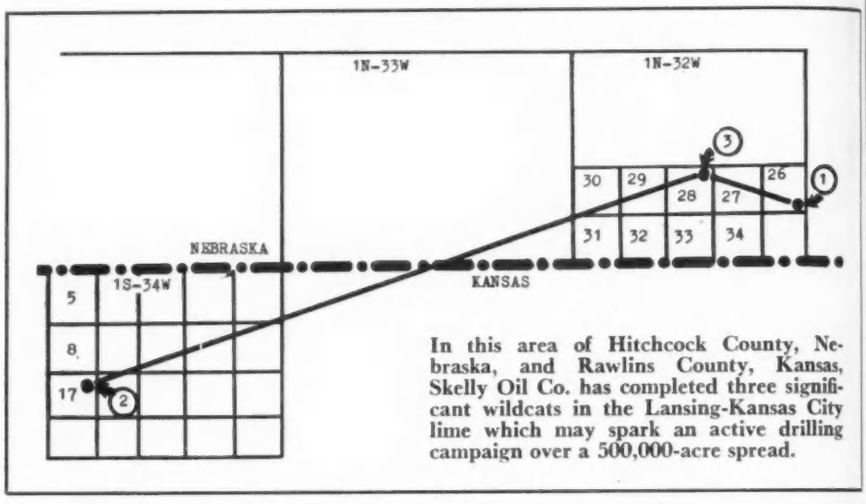
Drilling prices vary, since both formation and terrain demands vary widely in different areas of the basin. Prices are quoted from $5 to $15 per foot, and examples of each are not hard to find.

The rig population is not large in terms of the total area. Time on a well to around 9,000 feet can run from a little less to a little more than 30 days. On some of the deeper holes, much longer stands may be expected. Considerably less than 30 days are necessary to drill and finish a well in some of the shallower developments.

The Green River, like many other Rocky Mountain areas, has had a relatively stable rate of winter drilling during the past five or six years.

Multiple-pay producers apparently are to be the rule rather than the exception for the Basin, judging from experience at Desert Springs, Trail, Big Piney and other fields. Both dual completions and separate pool drilling programs are used in the basin. Procedure in this respect has not been stabilized.

With continued development, which now appears certain, and with additional gas outlets also an apparent certainty, the Green River Basin appears as one of the more active of Rocky Mountain areas for at least the next five years. —**The End**



In this area of Hitchcock County, Nebraska, and Rawlins County, Kansas, Skelly Oil Co. has completed three significant wildcats in the Lansing-Kansas City lime which may spark an active drilling campaign over a 500,000-acre spread.

Rank wildcats open new area in Kansas-Nebraska

THREE OIL producers approximately 18 miles apart are opening a new area in northwestern Kansas and southwestern Nebraska which may result in one of the most active drilling campaigns in recent years west of the Central Kansas Uplift.

The producers, rank wildcats, have been completed by Skelly Oil Company in Rawlins County, Kansas, and Hitchcock County, Nebraska. Skelly owns more than 400,000 acres in the two-county area. But sufficient acreage is open or under lease to independents to assure an active play.

Skelly made the initial discovery at the Lewis 1, Sec. 26-1n-32w, Hitchcock County, Nebraska. At 3862-64 feet the well swabbed 168 barrels of oil in 24 hours from Lansing-Kansas City lime. A west offset was dry but an east offset produced.

Interest in the area's possibilities awakened when Skelly completed a second producer 18 miles southwest of the Lewis well in Sec. 17-1s-34w, Rawlins County. In this well, the Cahoj 1, the Lansing was topped at 4,026 feet. After perforating at 4,267-77 feet the well swabbed at the rate of 56 barrels an hour. Reperforated at 4,227-36 feet the well swabbed 154 barrels in three hours.

The third wildcat is the Reiher 1, Sec. 28-1n-32w, Hitchcock County. Here the Lansing was topped at 3,678 feet and after perforating at 3,910-20 feet the well swabbed at the rate of 88 barrels a day.

The play is based on extensive seismic surveys which indicate the existence of individual highs. There is no evidence that wells Nos. 1 and 2 in Hitchcock County, Nebraska, and Rawlins County, Kansas, respectively, are interconnected or form a common reservoir. Development will depend on hitting the highs. It's a "wide open" play which is already attracting considerable attention.

New technique decreases deflection drilling costs

Success of the operation depends upon the availability of hydraulic horsepower and selection of the bottom-hole assembly

By Roy P. Dwyer, Engineer
The California Company
Venice, La.

CONTROLLED DIRECTIONAL drilling has become an important factor in the economical exploitation of reserves which lie under inaccessible or costly surface locations. With the advent of offshore development of the tidelands and the increase in townsite and river-bottom drilling, a boom in directional drilling has occurred.

Until recently the conventional means of deflecting a bore hole consisted of using three types of equipment: whipstock, spud bit and knuckle joint. These methods require considerable time as a result of tripping, changing bottom-hole assemblies, and circulating to condition the hole. Additional equipment in the form of bits, hole-openers or pilot reamers, substitutes, small drill pipe, and monel pup joints are required.

The jet-deflection method has been developed and used to accomplish the deviation of a bore hole at a minimum cost. This method allows a full gage hole with gentle changes in direction and deviation to be drilled with savings in time, bits, and extra equipment, and without the hazards of the older conventional tools. As the non-magnetic drill collar is always in the bottom-hole assembly, the hole can be surveyed with confidence at all times regardless of the angle or direction. As deflection is accomplished with a conventional bit and bottom-hole assembly, trips are considerable less frequent.

The conception of this method was based on the knowledge of the tremendous energy available in a fluid jet stream and the idle hydraulic horsepower at hand on a rig. Although some rigs are handicapped with small pumps and prime movers, more and more are changing to larger pumps in order to drill more efficiently in all circumstances.

Several improvements have been made in the jet-deflection method:

- A full-gage hole is being drilled with two of the three jets plugged. However, this necessitates trips to pick up drill collars.
- Two small jets (¼ or ⅛ inch) and one large jet (¾ or ⅞ inch) are being used.
- A conventional drilling assembly, drill collars and stabilizers, is the normal bottom-hole assembly in use today.

On routine wells in the Louisiana Gulf Coast area with normal deflection angles of 15 to 20 degrees, a directional hole can be drilled in 15 to 20 percent additional time over that required to drill a straight hole if the deflection point is not too deep. Higher or lower angles may require more time, as the angle is more difficult to maintain at higher angles and the direction tends to drift more at lower angles.

In one field where 15½ days are required to reach total depth, the average time to drill a directional hole is 17 to 20 days.

Two wells drilled recently offshore with the same drilling rig from the same location will serve as a good example. A straight hole was first drilled to 7,250 feet in 9½ days with 99 rotating hours and 5 bits being required. A directional hole was then drilled with the objectives being to be out 2,050 feet at a true vertical depth of 4,450 feet and 3,765 feet out at a true vertical depth of 7,250 feet. Both objectives were attained in 14½ days requiring 141 rotating hours and 7 bits, even though 1,050 feet more hole were drilled than for the straight hole. The hole was deviated at 500 feet, the direction and angle obtained, and surface casing set through the buildup. It was necessary to jet between 4,000 and 4,700 feet in order to correct direction. Otherwise the hole was drilled to total depth without the necessity of further changes in course.

Tables 1 and 2 indicate savings resulting from use of the jet-deflection method wherever possible. Table 1 shows the average of costs of deflect-

ing and drilling a 15-inch surface hole using the jet-deflection method, as compared with using a whipstock. The figures used are averages of several wells and should reflect day-to-day economies to be expected.

It should be noted that drilling fluids are not included in the breakdowns, as the daily costs of treatment vary from field to field. Table 1 is included as conditions are more nearly the same so that the comparison should be more nearly exact. Table 2 shows the drilling costs for a 10,250-foot true vertical depth well. In some of the wells included under the jet-deflection method, one or two whipstocks were required at deeper depths. The major factors involved are days required to drill and the equipment involved.

The jet-deflection method has proved to be a valuable means of double doglegging a hole. This requires the deflecting, drilling, and straightening of a bore hole in order to penetrate the producing zone or zones vertically. Casing usually is run after the hole has been straightened and the rest of the hole drilled normally. Appreciable savings can result from this practice. Recently, 40 hours were required to deflect a well 175 feet, whereas 15 hours are normally required to drill the same hole straight. It is estimated that a minimum of four days would have been required to accomplish the same objective with a whipstock.

Another practical use for the jet-deflection method is in side-tracking off of a cement plug or from the low side of a directional hole. This is accomplished in the same manner as deflecting or changing the bore-hole direction. The bit used to "dress off" the cement plug can be used for deflection if the proper size jets are installed and oriented before running the bit. Approximately 6 hours have been required to sidetrack off of a cement plug. In the case of an uncontrolled sidetrack in a straight hole where direction is unimportant, it is not necessary to even run a non-magnetic drill collar.

Hazards. No instances are known of to date in which a fishing job has resulted from the use of the jet-deflection method. However, the use of stabilizers in the drill-collar string is considered essential to prevent the differential sticking of the collars while jetting on bottom.

Limitations. Excellent results have been obtained using the jet-deflection method to 6,000 feet. However, at this point the successful application decreases with increased depth. Good results have been obtained to 8,500 feet with a conventional bit, but not with the desired consistency. The factors which probably influence the erosion are decreasing bit hydraulic horsepower, harder formations, and the cushioning effects of the hydrostatic head on the jets.

The hydraulic horsepower available on a rig is a big factor in the speed with which a bore hole can be deflected and sometimes in the success of the operations. An absolute minimum of 400 available hydraulic horsepower can be used at shallow depths; however, unreliable results may occur. At least 700 available hydraulic horsepower is recommended to obtain good results successfully and consistently. The ability of the directional operator is a bigger factor in the efficient use of the jet-deflection method than with conventional tools. He must develop a technique of jetting which is not required when using a whipstock. His selection of the proper bottom-hole assembly for a given situation is of utmost importance, with success or failure being dependent thereon.

Considerable difficulty was encountered originally with the erosion of the approach hole leading to the large or orienting jet of the relatively large volume of fluid flowing through the approach. This situation has now been generally overcome by enlarging the approach hole and cementing the jet in place.

Future of jet deflection. Practically all work to date using the jetting method has been done using a conventional bit with but slight modifications. It is believed that the operational depths can be greatly increased by the development of bits more adaptable to the method. Of prime importance is the location and position of the orienting jet with respect to the bottom of the hole. As more knowledge is acquired of the action of a jet stream in a high-pressure fluid atmosphere, the practical extension of the efficient use of this method will be extended.

The author wishes to express appreciation to The California Company and to California Research Corporation for the release of and permission to present this paper. Licenses under the jet-deflection method patent are available on a non-exclusive basis from the latter. This article was condensed from the paper "Recent Advances in Directional Drilling" presented at the Spring Meeting of the API Southern District Division, New Orleans, March 1959. —The End

TABLE 1—Relative cost of drilling a deflected surface hole while using the jetting method and whipstock method

	Jetting	Whipstock
Contract drilling	$1,860 (30 hours)	$5,520 (90 hours)
Directional services	705	1,170
Bits and hole openers	540	1,710
Stabilizers	710	880
Non-magnetic drill collar	75	150
Substitutes	60	180
Supervision	100	200
	$4,050	$9,810

TABLE 2—Cost of a 3,000-foot deflection hole at 10,250 feet true vertical depth compared while using jetting and whipstock method vs. whipstock method

	Jetting and Whipstock	Whipstock Only
Contract drilling	$32,000	$56,000
Directional services	3,640	6,100
Bits and hole openers	4,215	6,260
Stabilizers	1,100	1,500
Non-magnetic drill collar	650	1,350
Substitutes	200	500
Supervision	900	1,700
	$42,705	$73,420

Down-hole plastic pipe installations draw interest

Successful applications include salt water disposal wells, water supply wells and waterflood systems, shallow pumping wells

By E. D. Edmisten
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Sand Springs, Okla.

THE OIL PRODUCING industry has expressed considerable interest in both reinforced and non-reinforced plastic pipe as an aid to corrosion control. Inadequate quality control and misapplication, two major sources of trouble for early day plastics, have been rectified and plastic piping now is being used successfully in many aboveground installations. However, the role of plastic tubing in salt water disposal, water supply and producing oil wells has not been surveyed extensively. It is the purpose of this article to review some of these applications to acquaint operators with advantages, limitations and design considerations as applied to down-hole plastic tubing installations.

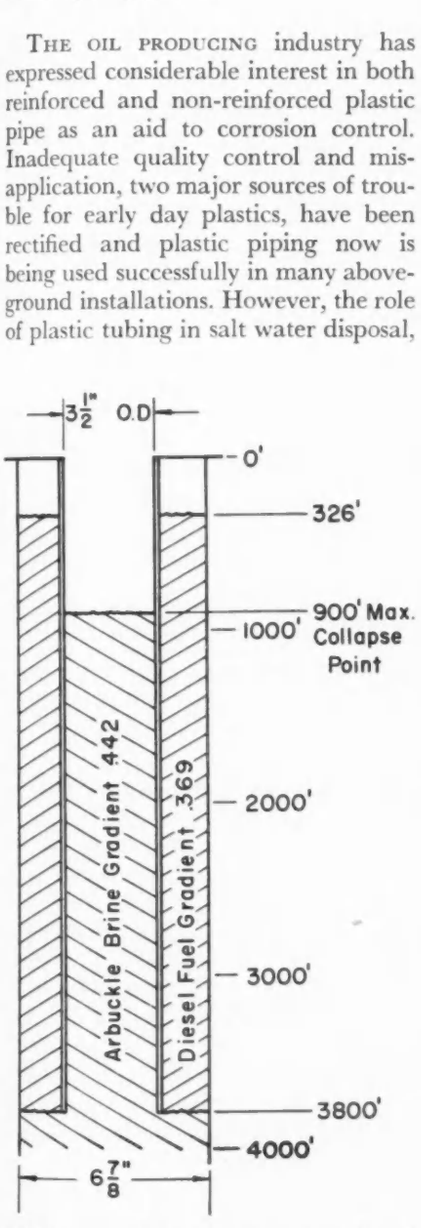

FIGURE 1—A typical "balanced column" salt water disposal well common to the Mid-Continent area. This well was designed against static fluid level. In other areas, where receptivity is lower, the design to changed to working fluid level.

There are many kinds and forms of reinforcement available today. Among those most commonly used are: continuous glass fibers, staple glass mats, asbestos rovings, sisal mats and many synthetic fibers and cloths. These materials are imbedded within the resin to increase strengths and generally improve properties of the finished product.

Thermoplastics, like polyvinyl chloride and the butyrates, are heat formed. They can be reheated and reformed indefinitely into a variety of shapes. Thermoplastics thus are restricted to lower operating temperatures than the thermosets, which are changed chemically into a permanent form when heated in processing. Additional heating will not cause deformation in the thermosets.

Reinforced plastic tubing discussed in this article is manufactured from a thermosetting resin, in which thousands of strands of continuous glass fibers have been bound. The geometry of the glass fiber pattern reinforces the tubing in both axial and hoop direction, and accounts for the high loads to which this type of pipe can be subjected.

Since plastic tubing is essentially orthotropic, it is impossible to rate in the same manner as steel. Tensile-collapse charts should be consulted when designing down-hole strings. Although collapse rating is a fixed maximum value and should not be exceeded, the axial tensile load can be increased at lower collapse loads.

As an example, 3-inch 350 psi tubing is rated at 350 psi collapse load at 7,500 pounds of axial tensile. At 60 percent of the collapse load (210 psi), tensile load can be increased to 152 percent or 11,400 pounds. This example is shown in Figure 2, which is applicable to all grades and sizes of tubing discussed here, or shown in Table 1.

Salt water disposal well. A typical salt water disposal well in the Kansas area has the following general field conditions:

TD—4,000 feet
Length of Casing (7-inch-17 pounds)—3,800 feet
Length of Tubing—3,800 feet
Static fluid level—900 feet
SpGr Disposal fluid—(Arbuckle brine) 1.020 Gradient—.442 psi/feet
SpGr annulus fluid (Diesel)—.852 Gradient—.369 psi/feet
Disposal rate—10,000 bpd

Since the purpose of the tubing is to resist corrosion and at the same time protect the casing, the "open-end" type of installation should have the annulus filled with a hydrocarbon product. Fluids normally used are kerosine, diesel fuel or third run gasoline.

The static fluid level to the bottom of the tubing is balanced by this annulus fluid, protecting the casing string at static conditions. As the well begins to take disposed fluid (Arbuckle brine in this case), there is a slight movement of the annulus columns due to the over balancing effect of the greater head in the tubing. Since most disposal wells in the Kansas area take fluid on a vacuum, this movement is restricted by casing pressure build-up. In areas where working fluid level is substantially higher than static fluid

TABLE 1—Here are load limitations and ratings of one type of reinforced plastic tubing.

Tubing Size (Inches)	Wall Thickness, Inches	Wt/Ft T & C	Rated Collapse	Rated Tensile @ (Pounds)	@ Degrees F
2	.28	1.20	700	4500	120
2	.19	.90	150	2800	120
2½	.28	1.50	500	5000	120
2½	.19	.80	80	2000	120
3	.28	2.05	350	7500	120
3	.19	1.76	100	4600	120
4	.34	3.00	300	7000	120
4	.30	2.62	125	5000	120

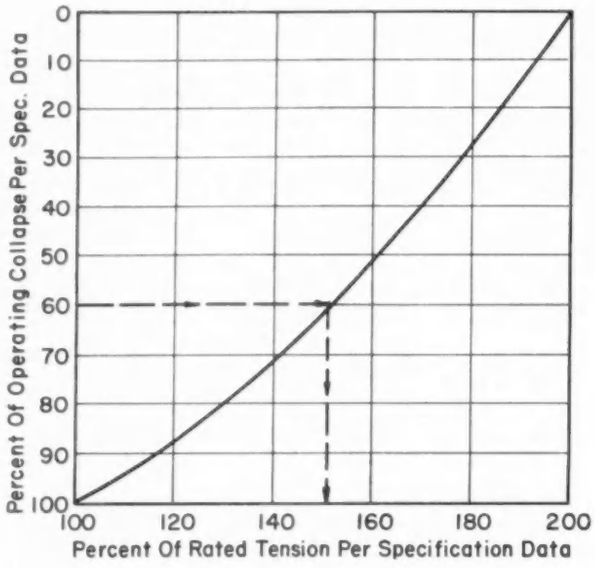

FIGURE 2—The axial tensile load of plastic tubing can be increased at lower collapse loads. As an example, 3-inch, 350 psi collapse tubing is rated at 7,500 pounds tensile and 350 psi collapse at 120 F. As collapse is reduced to 60 percent (210 psi), the allowable tensile is increased to 152 percent (11,400 pounds).

level, the design is changed to reflect these conditions. This design has been effectively used for more than seven years. Figure 1 shows the well as designed for "open-end" installation.

Calculations. The first step in design is to determine bottom hole pressure, and then calculate the equivalent column footage of annular fluid to properly balance the string.

$$\text{BHP} = (.442 \text{ psi/feet}) \ (2{,}900 \text{ feet}) = 1{,}282 \text{ psi}$$

then

$$\frac{1{,}282 \text{ psi}}{369 \text{ psi/feet}} = 3{,}474 \text{ feet equivalent annular column footage}$$

This means a balanced condition will exist when the annulus is filled to (3,800-3,474) or 326 feet with diesel fuel.

Since static level is at 900 feet, the maximum collapse on the string is (900-326 feet) (.369 psi/foot) = 212 psi.

The disposal rate of 10,000 barrels per day indicates the need for 3-inch tubing. Knowing the ID of 7 inch-17 pound casing and the OD of the tubing, it is a simple matter to calculate the volume of fluid necessary to fill the annulus to the 326 foot level.

Table 1 shows that two grades of 3-inch tubing are available, rated at 350 psi and 100 psi collapse loads, respectively. To determine the crossover point to the lesser rated tubing, the following equation is used:

$$(\text{Collapse}_{\text{Max.}} - \text{Collapse}_{\text{Allowance}}) = (\text{Gradient}_{\text{Tbg.}} - \text{Gradient}_{\text{Casing}}) \text{ X}$$

where X is feet below maximum collapse point.

$$\frac{(212 \text{ psi} - 100 \text{ psi})}{(.442 \text{ psi/ft} - .369 \text{ psi/ft})} = \text{X} = 1{,}534$$

then, changeover point is 1,534 + 900 = 2,434 feet from surface.

As a tapered string, this well would be designed to use 2,434 of the 350 psi tubing and 1,366 feet of the 100 psi collapse rated tubing. The final check point is the maximum tensile. Applying a buoyancy factor to the weights given in Table 1, the top joint tensile load is 3,990 pounds. A check of the tensile-collapse curve (Figure 2) shows that at 212 psi collapse (59 percent), the allowable tensile is 154 percent (11,550 pounds). This value is practically coincident with the example cited previously.

Salt water disposal wells using packers. Packers often are used in salt water disposal wells, and reinforced plastic tubing installations of this type have been in service for more than six years. Again, the design criteria are disposal rate to determine size, casing size and static fluid level. Collapse limitations are the important consideration in most applications although with retrievable packers the tensile and beam strengths also are important factors. Three types of retrievable and non-retrievable packers have been used successfully.

Water supply wells. A water supply well lifted by down-hole electric pump also can be equipped with plastic tubing. The design is limited to tensile load, burst load and torque action. An installation of this type is operating without difficulty after two years service.

Another class of supply wells is the modified gas lift, in which gas is injected into a concentric spaghetti string and brine is lifted to the surface. The string is designed against tensile and burst in this application.

These general types of installation are used primarily to supply injection water to water-flood areas. The lifted water becomes a part of the system and is treated according to the requirements of the flood. Tubing strings vary from 400 feet to 2,300 feet in length, and the size and stages of pumps are dependent upon depth and output requirements.

Water-flood systems. One interesting installation of this kind is the use of plastic tubing to:

1. Lift water in supply wells
2. Transport water to pits
3. Move fluid to pump house (pump inlet)
4. Transfer brine to injection well (pump outlet)
5. Gather brine and crude from producing wells
6. Transport from separator to disposal tank
7. Move brine to disposal well
8. Carry water to disposal sand, in capacity of disposal well tubing.

Other such complete systems are in operation, but this is the most complete tubing-to-tubing installation.

Production pumping well. For present pumping well installations, an all-bronze hydraulic tubing tension anchor, with drain incorporated in the body, is hung above the pump. This anchor allows a dual safety control, since it can be released by rupturing a shear pressure ring. In the event this will not release the slips, a tensile pull of 22,000 pounds will shear the slip pin. The slips have been pitched steeper than a normal packer or anchor and will begin to hold at only 4 pounds.

While the same considerations of steel tubing design, such as stroke length, frequency, depth, fluid level, fluid gravity, pump type and rod weight must be evaluated, far more

Continued on Page 109

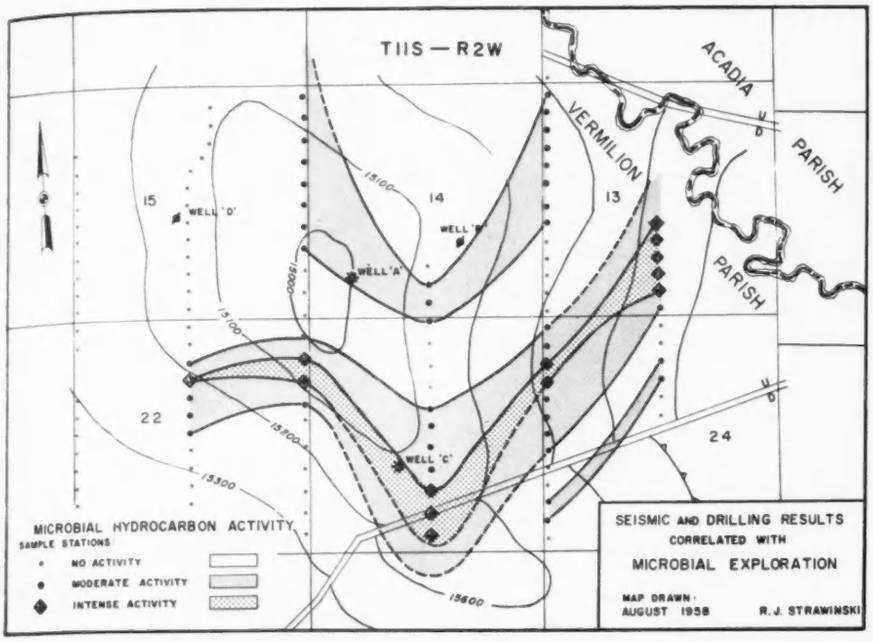

FIGURE 1—Microbial anomalies, developed independently of other data after completion of discovery well "A" (Sid Richardson L. P. Bonin 1, producing from the interval 15,025 to 15,066 feet), are here superimposed on subsurface interpretation of seismograph and drilling data after three more wells, one successful and two dry, had been completed. Gas wells fall into areas of intense or moderate microbial hydrocarbon activity, while dry holes are in areas of no activity. Wells completed after the Bonin are "B", Richardson, B. Maboules 1 (dry hole); "C," Richardson, N. H. Brouddard, gas well producing from intervals 15,812 to 15,816 feet and 15,865 to 15,880 feet; and "D", Richardson and Bass P. J. Woods, dry hole. The Maboules dry hole was drilled to 16,653 feet and the Woods to 15,467 feet.

Microbes locate gas production in field test

By Dr. R. J. Strawinski,
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MICROBIAL PROSPECTING for oil and gas has been tried out on a field scale for the first time in Louisiana. The results—two producers and two dry holes—were as predicted.

Microbial prospecting is a positive approach to oil prospecting which seeks a more direct indication of oil and/or gas. The method will not always point out the exact location of oil, because the escaping gas on which the microbes feed does not necessarily rise vertically to the surface. However, experience confirms that some oil and/or gas is in the immediate vicinity.

The technique involves tiny micro-organisms living in the soil. They are not visible to the naked eye. Certain of these micro-organisms live on hydrocarbon gases which escape to the surface.

By taking microbial samples over a given area of land, it is therefore possible to determine whether or not oil deposits are present by the amount of activity registered by these minute bacteria.

Under cultivation in the laboratory, the number of bacteria in a sample can be measured by the amount of gas they consume. Where they abound on the surface, hydrocarbon deposits are indicated in the vicinity.

The method employed has been previously described by Strawinski.[1,2] This survey was conducted in Southwest Louisiana. The area was selected for several reasons. Only one well was present, a wildcat discovery well; hence, little was known of the geology prior to conducting the microbial survey. The survey was thus diagnostic. The immediate prospects for active development of the field appeared to be good. No subsurface information was made available prior to the microbial survey nor was it desired. This condition was highly desirable to eliminate any human bias whatsoever from creeping into the work, even at the price of improperly locating test lines because of the lack of such information.

The majority of the samples were collected at 400-foot intervals. Test lines were spaced at one-half mile intervals. Sometimes samples were not collected at the stated intervals in the approximately two-mile-long test lines because of the possibility of damage to rice crops. Methane, ethane and butane were employed as the test gases.

The results obtained are presented in Figure 1. These results demonstrate that two areas were found to have anomalous hydrocarbon concentrations and the presence of the indicated hydrocarbon deposits was proven by drilling (gas wells). Conversely, the areas found to be "normal" were also confirmed by drilling (dry holes). The location of these wells was based on SEISMIC AND DRILLING DATA ALONE. Complete subsurface details were not available.

In this instance, and possibly in many others, drilling seems to have confirmed the direct or positive microbial indications. From these results, it is evident that microbial exploration can be an important tool in searching for oil. Combined with geophysical methods, microbial prospecting will improve chances for locating petroleum deposits. Particularly where other methods cannot readily be used, for example, stratigraphic accumulations, microbe methods may be helpful.

ACKNOWLEDGMENT

The senior author wishes to thank J. B. Lovejoy, exploration manager, Richardson and Bass, Fort Worth, for his permission to conduct this survey; to the landowners who granted trespass privileges; to J. S. Gauthier, geologist, Louisiana State Geological Survey, Baton Rouge, La., for his interest and assistance; and to the Office of Naval Research, Microbiology Branch, for financial support.

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[1] Strawinski, R. J. 1954. "Prospecting" U. S. Patent No. 2,665,237. Assigned to Texaco Development Corporation.
[2] Strawinski, R. J. 1955. "A Microbiological Method of Prospecting for Oil" WORLD OIL, November, 1955, p. 104.

WASHINGTON SCENES. Governor Albert D. Rosellini of Washington State (above center) watches oil and gas flowing from Sunshine Mining Company's Medina 1 at Ocean City in August 1957. This was Washington's discovery well. A magnetometer survey (below left) being conducted in the Ocean City area. Above right is Utah Consolidated's Swanson 22-1, which found oil and gas shows at 2,100-2,300 feet and gas at 3,940 feet. Below right is Union Oil Company of California's State 3. This well was drilled in 1949 finding shows of

What are the prospects in Washington State?

Untested oil and gas possibilities are tremendous, but will yield only to those operators with know-how and the means to find it

By F. H. Wurden, Petroleum Consultant
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oil and gas in the Blakely formation that touched off the oil play in Washington. Sunshine's Medina 1 is located about 600 feet north of this well, which is temporarily abandoned.

(Photographs courtesy the author and the Department of Conservation and Development, Washington State.)

THE OCEAN CITY ANTICLINE, a seismic prospect located on the Pacific coast of Washington state, ranks as that state's main oil prospect despite 10 unsuccessful attempts in as many years to develop commercial oil and gas production. All tests drilled on the prospect reported strong shows of oil and gas. One well, Sunshine Mining Company's Medina 1 drilled in 1957, has produced more than 8,000 barrels of high gravity oil.

Most of the tests have been drilled on a quarter-mile wide sand dune strip between the Pacific ocean and the upland timbered area. Operators have been plagued by engineering difficulties and, due to a lack of information on subsurface conditions, completion and testing practices have proved inadequate. As an example of the bad luck encountered in the area, Union Oil Company, discoverers of the structure (1946), drilled five of the 10 wells, and was forced to abandon a critical deep test following a series of fishing jobs and cementing failures. The test, Union's State 3, was projected to 12,000 feet for a test of deep-lying Eocene sediments. This well encountered high pressure gas at about 3,700 feet. After a number of unsuccessful attempts to complete, it was abandoned at 9,344 feet.

A table on Page 98 lists all wells drilled on the Ocean City prospect up to December, 1958.

In general, sediments in the Ocean City area from 1,500 feet to a total penetrated depth of 9,344 feet emit a characteristic gasoline or kerosine odor. Numerous live shows of oil and gas have been found throughout this interval. Miocene through Eocene marine sediments are present to a depth probably exceeding 20,000 feet.

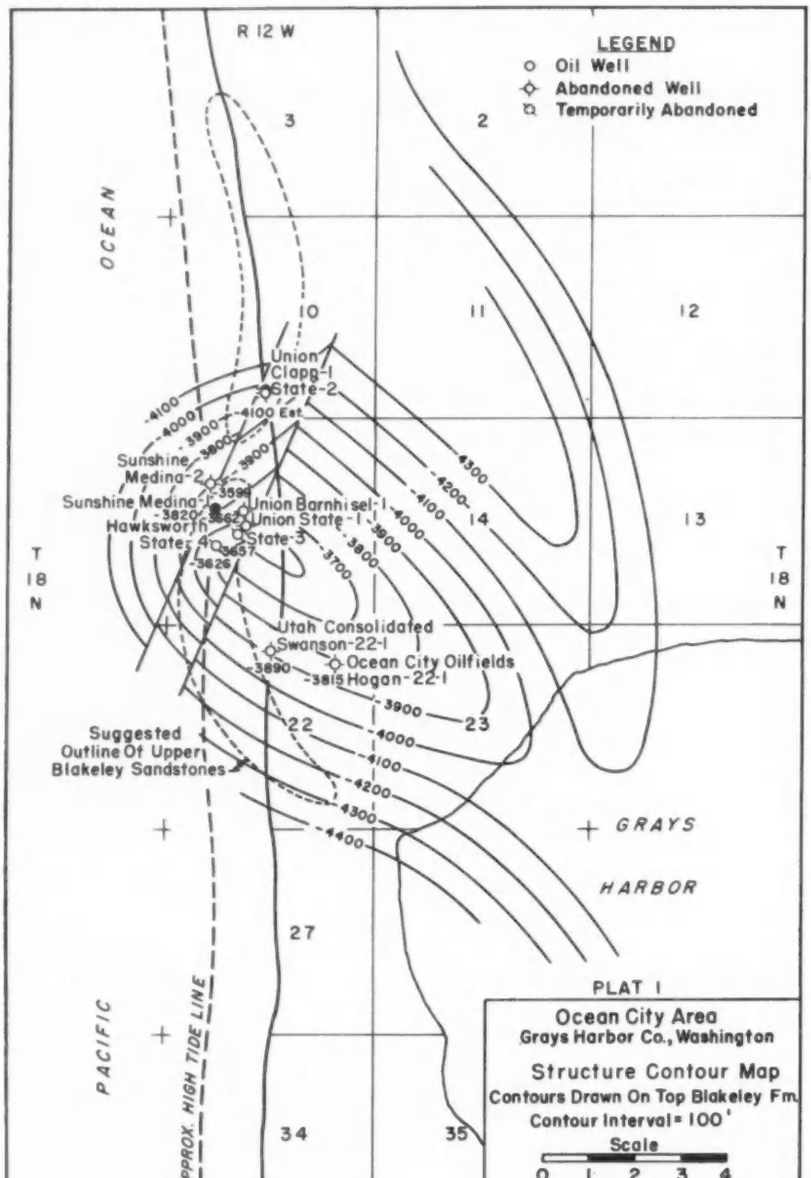
GEOLOGY

Structure: Regional—The Ocean City anticline centers around Section 15—T18N-R12W, Grays Harbor County, and is located on the east flank of a deep sedimentary basin that roughly parallels the coast of Washington. Available structural data indicate that the coastal area of western Washington is strongly folded and faulted, and occasionally intruded by Tertiary igneous masses.

The Olympic Mountains form the predominant structural feature of the area with present structures along the

About the Author

Fred H. Wurden helped organize and supervise Sunshine Mining Company's exploration program in Washington state prior to March of 1958. He is now a partner in the firm of Larsen and Wurden, petroleum consultants, in Billings, Mont. Wurden is a graduate Colorado School of Mines. Before he joined Sunshine Mining in 1956 he was employed as a geologist with Murphy Corporation in Billings.



Subsurface geological interpretation of the Ocean City anticline, Grays Harbor County, Washington, shows the productive area as a narrow faulted zone. Lenticular sands are indicated.

coast being associated with the major tectonism involved in building these mountains. The southwest flank of the Olympics is probably a large upthrown fault block represented by "Quinault Ridge" extending to the southwest from Quinault Lake.

Although surface sediments throughout the area are quite strongly folded, it is possible that some of this folding will die out at depth.

Local—As previously noted, the Ocean City anticline was originally mapped by the Union Oil Company and showed up on a seismic profile which the company ran along the beach. North of Section 15, T18N, R12W, this profile indicated steep north dips; while south of Section 15, more gradual dips to the south were indicated. Several faults were also suggested by this work. On the basis of the wells that have been drilled, Union's seismic work, and gravity work conducted by Sunshine Mining Company, structure contours have been drawn and are shown on Plat 1.

These contours show a faulted anticline trending roughly northwest-southeast with the highest part of the structure located in the south half of Section 15, T18N, R12W. Although the total structural closure on the anticline is unknown at this time, it probably exceeds 400 feet. To the east the sediments rise rapidly, with Eocene outcrops being on the surface northwest of Hoquiam (a town about 27 miles east of the prospect). The north flank of the structure is limited by a syncline trending through Sections 3, 10, 11 and 14, T18N, R12W. To the south the structure is limited by a syncline trending northwest-southeast through Sections 34 and 35, T18N, R12W. South of the township line the sediments again dip to the north as they rise up on the Duck Lake structure. Although no structural data are available west of Section 15, T18N, R12W, it is assumed that the sediments continue the trend from Eocene outcrops at Aberdeen and dip sharply to the west.

Faulting—Two faults have been found in the area on the basis of electric log correlations alone. These are shown on Plat 1 trending north-northeast through the crest of the structure. Although the trend of these faults was originally plotted on the basis of well control only, they also parallel the trend of a major fault along the west flank of Quinault Ridge. Each of the faults dips to the southeast with the southeast side downthrown. Other faults are possibly present but cannot be definitely located by well control alone.

The easternmost of these two faults cuts Union's State 1 and State 3 in the Lower Miocene Ocean City formation, resulting in a shortening of this interval in these two wells. The same fault apparently cuts out the middle sandstone member of the Astoria formation in Union's Barnhisel 1.

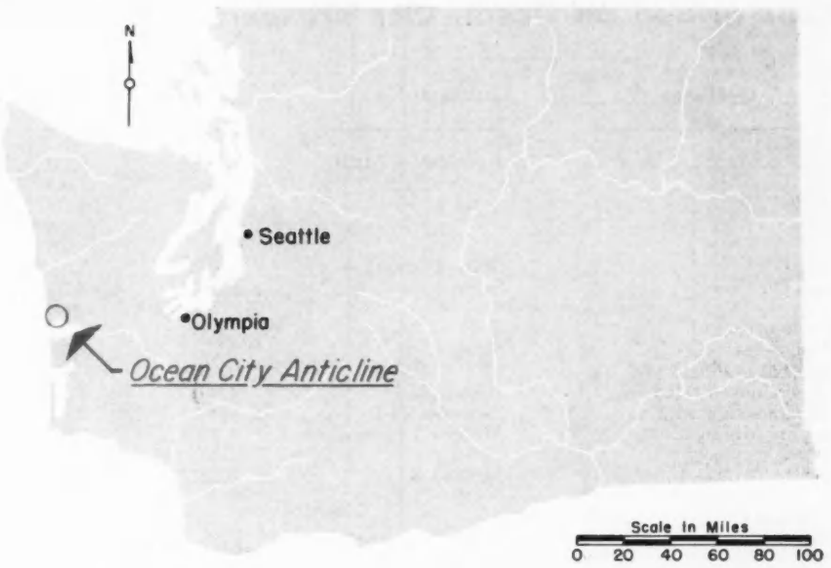
The westerly fault crosses the Medina 2 at about 1,500 feet, cutting out an interval equal to that between about 1,500 feet and 1,650 feet in the Medina 1.

Stratigraphy: General. Major stratigraphic units can be correlated on a lithologic basis for considerable distances in western Washington. As is often characteristic of Tertiary sediments, however, individual sandstone units are quite lenticular and difficult to predict.

Eocene sediments: For all practical purposes, the basement rocks throughout most of western Washington are composed of the middle Eocene Crescent volcanics. These rocks owe their name to exposures around Crescent Lake on the northern border of the Olympic Peninsula and are predominantly a sequence of lava flows with

secondary amounts of pyroclastic and sedimentary rocks. In many parts of western Washington the Crescent formation is unconformably overlain by the middle and upper Eocene McIntosh and Skookumchuck formations. In the Chehalis area, the McIntosh formation is of marine origin and consists of tuffaceous silstone and shale with minor amounts of sandstone, while the Skookumchuck formation is of brackish marine origin consisting of clean, porous and permeable sandstones with numerous coal and silt interbeds.

Marine equivalents of the upper Eocene Skookumchuck and Middle Eocene McIntosh formations undoubtedly underlie Oligocene sediments in the Ocean City area. The potential of these Eocene sediments is illustrated by a well drilled by the Ohio Oil Company, just north of Aberdeen in Section 5, T17N, R9W. This well flowed an estimated 2,500 to 3,000 barrels of hot, brackish water per day from an Eocene sandstone. Untested Eocene sediments in the Ocean City area could cause the oil industry to take notice of western Washington's oil and gas potential.



Index map of Washington State shows location of area discussed here.

Blakeley formation: Uncomformably overlying Eocene sediments, the Blakeley formation contains more than 6,000 feet of sandstone, shale, and conglomerate. A total of about 5,650 feet of these sediments were penetrated by Union's State 3. A characteristic petroleum odor permeated almost the entire unit. The shales of the Blakeley formation are typical source beds for oil and gas and are the "smell muds" found along the Pacific Coast of Washington. Numerous oil and gas seeps have been found in the formation which is equivalent in part, at least, to Weaver's Hoh formation to the north and to the Twin River formation on the northern border of the Olympic Peninsula. This formation is considered to be predominantly Oligocene in age. In the Ocean City area, the presently known sediments of the Blakeley formation can be divided into four lithologic units.

The lower-most unit, as found in the State 3, consists of a dark grey, fractured shale of unknown thickness.

Overlying this unit is about 2,550 feet of conglomerate and sandstone with minor amounts of shale. Numerous cores in the lower 900 feet of this interval had good shows of oil and gas. However, the permeabilities were extremely low and unless formation fracturing will help, it is questionable whether or not this zone will ever produce appreciable amounts of oil or gas. The zone has not been adequately tested, having had 2,665 feet of heavy mud over it when swabbing operations were discontinued in Union's State 3.

About 1,650 feet of shale with thin sandstone beds overlies the lower conglomeratic zone. Several shows of oil were found in these very thin sandstone intervals in Union's State 1.

By far the best shows of oil and gas in the Ocean City area have been found in the upper 700 to 1,000 feet of the Blakeley formation. Sediments in this unit have been described as a gouge zone, grit zone etc. Actually this interval is predominantly a very poor type of conglomerate containing up to first sized subangular pieces of hard sandstone, siltstone, and hard black shale in a matrix of soft, dark grey shale. Most of the oil and gas produced in the field has come from several tight fractured sandstones in the upper part of this interval. In the lower part of this zone, at about 4,300 feet in the State 3, a fairly good oil sand was penetrated with excellent permeabilities. This sandstone probably correlates with the sand at 4,170 feet in the Medina 2 and the sandstone interval between 4,330 and 4,450 feet in the Hogan 22-1.

Several high pressure oil and gas zones are present near the top of the Blakeley formation. The State 3, State 4, and the Medina 1 all produced oil and gas from these sandstones. Each of these three wells produced a different gravity oil. Obviously these different crudes are coming from separate reservoirs. In the Medina 1, a part of these sandstones were cored. Analysis showed almost no permeability and very low porosity, with oil and gas apparently coming from fractures in these sandstones. The sandstone at 3,700 feet in the State 3 is considered to be the same type of reservoir. Unfortunately the electric log did not penetrate to total depth in the State 4, making it difficult to evaluate these reservoirs.

The geological environment during Blakeley time is clearly recorded by the sediments deposited. During most of this time a near-by land mass was being rapidly eroded. In early Blakeley time there was apparently a long quiet period of moderately deep marine sedimentation as shown by the lower shale unit. Near-by uplift, probably in the Olympic Mountains, resulted in a period of rapid deposition, as shown by the lower conglomerate and sandstone interval. Either the adjacent land mass subsided or was reduced to a very low outline and continuing erosion and deposition resulted in the second shale unit. Near the end of Blakeley time this land mass began rising again, resulting in periods of landslide proportion deposition. This uplift continued until a large part of western Washington, including the Ocean City area, was raised above sea level and subjected to erosion. During this time the coastline fluctuated back and forth and at times probably approximated the present coast. Although other explanations

Wells drilled on Ocean City prospect to December 1958 . . .

Operator	Well No.	Total Depth	Oil and Gas Shows
Union Oil Co.	Barnhisel 1 (strat)	2,657′	1,140-1,573 feet, (gasoline-kerosine odors).
Union Oil Co.	Clapp 1 (strat)	3,997′	2,000; 2,460-70 feet, (oil); 3,650-3,730 feet, (gas).
Union Oil Co.	State 1	6,278′	3,700 feet, (gas); 3,884-3,928 feet, (gas cut mud); Perforated 3,630-3,885 feet, (swabbed 100 bbls. 37 gravity oil).
Union Oil Co.	State 2 (strat)	3,805′	3,585 to 3,769 feet, (gasoline-kerosine odors).
Union Oil Co.	State 3	9,344′	3,700 feet, (high pressure gas); Perforated 3,670-4,676 feet, (pumped up to 100 barrels of oil per day).
Hawksworth and Associates	State 4	3,771′	3,587-3,712 feet, (2 Mcf gas, 35-40 barrels 44.2 gravity oil per day).
Ocean City Oilfield and Utah Consolidated Oil	Hogan 22-1	4,864′	4,330-4,440 feet, (oil).
Utah Consolidated	Swanson 22-1	4,381′	2,100-2,300 feet gas; 3,940, (gas).
Sunshine Mining Company	Medina 1	4,130	3,952-58 feet (IP 180 barrels of oil; well has produced more than 8,000 barrels of oil).
Sunshine Mining Company	Medina 2	5,125	3,010-35 feet and 4,160-80 feet, (oil/gas).

are possible it seems likely that the sandstones in the uppermost Blakeley are ancient beach sands or offshore bars. If so, their trend should roughly parallel the present coast line. A suggested outline of these sands is shown on Plat 1. Although present data indicates that these uppermost Blakeley sands are fracture type reservoirs, a little experience with sandstone reservoirs in general will illustrate how rapidly these sands will clean up over a very short horizontal distance.

Ocean City formation: At the end of Blakeley time the area again subsided and about 1,700 feet of marine shales in the Ocean City formation were deposited. These sediments are also permeated with a strong gasoline or kerosine odor and are undoubtedly source beds for oil and gas. In the Medina 1 at about 3,010 feet, an excellent show of oil and gas in this interval is shown by a drill stem test between 3,010 and 3,041 feet which flowed oil and gas in 50 minutes. The Ocean City formation is a "heaving shale" which requires mud in excess of 14 pounds per gallon to drill the interval.

Astoria formation: At the end of lower Miocene time the area was again uplifted and subjected to erosion. As shown by the Swanson 22-1 and the Hogan 22-1 wells, deep channels were cut in the lower Miocene sediments and filled by the middle (?) Miocene Astoria sandstone. This sandstone is predominantly a blanket type sand covering a large part of western Washington, extending southward into Oregon, and deriving its name from outcrops along the Columbia River near Astoria, Oregon.

See Page 111 for a story on the propects of the Puget Sound area in northwest Washington State.

In the Ocean City area sedimentation continued, apparently uninterrupted into upper Miocene time, depositing about 1,000 feet of sands and shales in the upper Astoria unit.

Quinault formation: The Quinault formation consists of about 1,200 feet of sandstone of continental origin and derives its name from outcrops along the Pacific Coast near the mouth of the Quinault River, about 20 miles north of Ocean City. Logs, twigs, leaves and other organic matter are common. These sands grade upward into the present beach sands. The Quinault is Pliocene in age.

Area's oil possibilities are interesting. That oil and gas can be produced in the area is illustrated by the Sunshine Mining Company, Medina 1, which has to date produced more than 8,000 barrels of oil. Several different gravities of crude oil have been produced from the various wells in the field indicating at least four pressure oil and gas reservoirs in the upper Blakeley formation. Available information indicates that at least three of these reservoirs are tight, fractured sandstones. However, this does not eliminate the possibility of finding clean sandstone reservoirs in the immediate area.

Oil shows in the lower conglomerate zone of the Blakeley formation have not been properly tested. The future of the Ocean City field depends on this interval, untested Eocene sediments, and the upper 1,000 feet of the Blakeley formation.

If the sands in the uppermost Blakeley formation are beach sands in origin they will be long and narrow in shape and considerable care should be exercised in making new locations.

Drilling operations in this area will be expensive due to the "heaving shale" in the Ocean City formation. Mud weight in excess of 14 pounds per gallon is required to control this zone. Use of this heavy mud over a reasonable period of time probably will not damage the oil and gas reservoirs in the area.

Oil and gas to date has been produced from sandstones and not shale intervals. Even though these shales give off a strong gasoline or kerosine odor, it is very doubtful that appreciable amounts of oil or gas will ever be produced from them. In fact they are generally so soft that care should be taken during perforating so that no bullets enter a shale interval.

The use of slotted or perforated liners has resulted in considerable trouble in completing these wells. During drilling operations, oil and gas zones should be pinpointed by cores and drill stem tests. Pipe should then be cemented through these zones and perforated for production testing.

The history of the Ocean City area has been one of an endless series of troubles that have resulted in unfortunate expense to the operators, and others should profit from their experience. Western Washington has a tremendous untested oil and gas potential that will yield only to operators with the know-how and the means to find it. —**The End**

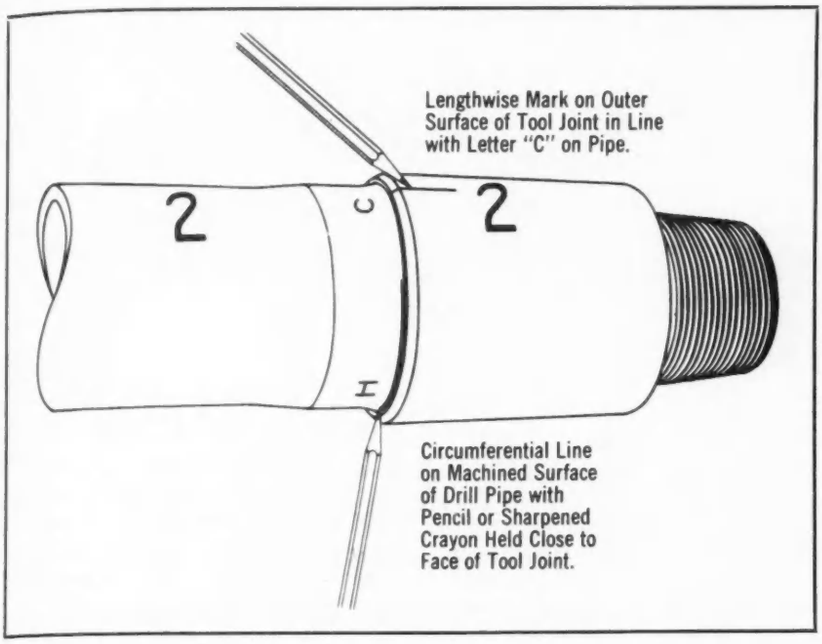

Lengthwise Mark on Outer Surface of Tool Joint in Line with Letter "C" on Pipe.
2
C
2
I
Circumferential Line on Machined Surface of Drill Pipe with Pencil or Sharpened Crayon Held Close to Face of Tool Joint.

FIGURE 1—(Above) Here is shown the proper "cold" and "hot" marking on the cold pipe and joint in preparation while making up of a heated joint.

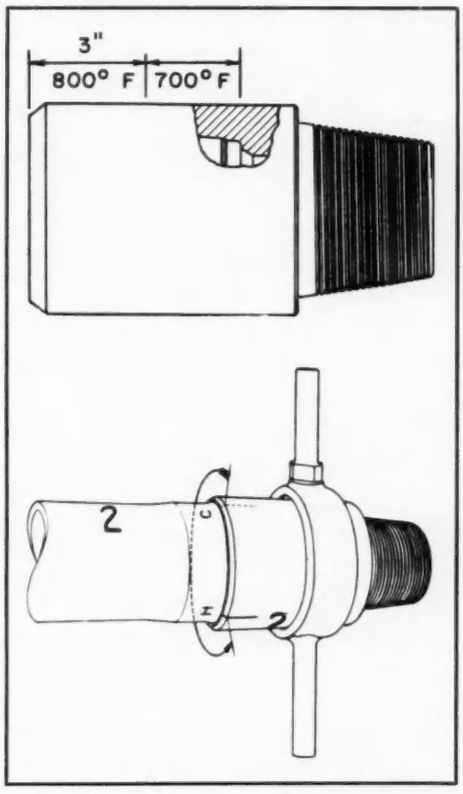


FIGURE 2—(Right) Drawing at top shows the proper exterior joint temperatures just prior to make-up. After correct temperature is reached, the joint is made up and advanced from "C" to "H" as shown at bottom.

Are your tool joints being properly applied?

Tool joints can be salvaged if accepted methods are used

WORN OR DAMAGED tool joints may be removed from the drill pipe by either one of two methods: (1) cutting with an acetylene torch, (2) heating with a dual purpose furnace. The second method is preferable because it does not destroy the tool joint and can be salvaged for further uses.

Torch cutting method. The torch flame should be held in a vertical direction. A slot should be cut starting at the open end and ending ⅛ of an inch away from the end of the pipe inside of the joint. This slot should then be enlarged to about 1 inch adjacent to the end of the pipe for a wedge.

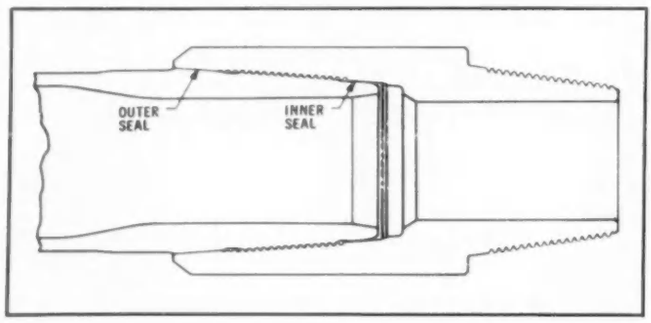
With the torch flame held horizontally, or parallel to the pipe, cut a channel approximately ¾-inch wide, starting at the back end or pipe end of the tool joint and ending in the previously cut slot. The bottom of this channel should be 1/16 of an inch above the pipe threads and seals. Extreme care should be exercised in performing this operation to insure against damage to the pipe threads and seals.

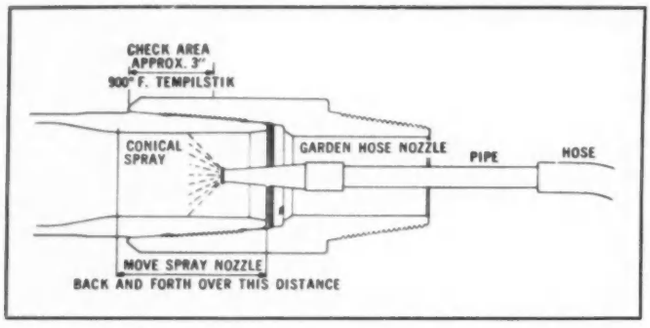
A wedge shaped chisel should be driven in the 1-inch wide slot as close to the pipe end as possible. This expands and loosens the joint and permits unscrewing by hand.

Furnace heating method. The pipe should be elevated to drain the quenching water through the pipe away from the hot tool joint. Encase the tool joint with the furnace and heat to 900° F. Then, remove the furnace and quench the inside of the pipe upset with a conical water spray. This spray of water should be moved back and forth during the quenching operation, being careful not to spray water on the inside of the hot tool joint. Then, holding the pipe stationary with a chain tong, place a second chain tong around the hot tool joint and unscrew the hot tool joint whenever the pipe has shrunk sufficiently to produce a loose fit.

Precaution must be taken so that the tool joint or drill pipe is not overheated (use tempilstik 950° F. for maximum temperature). Overheating will adversely affect the physical properties of either the pipe or tool joint and may result in failure. If the tool joint is to be considered as scrap, remove the peened portion of the tool joint at the outer seal by a cutting torch. This will prevent overheating of the drill pipe. On the other hand, if the tool joint is to be salvaged and if it is peened at the outer seal, torch cut the scrap drill pipe about 1 inch from the tool joint and remove the pipe dutchman by either the torch method or by a machining process.

Preparing double seal grip pipe and tool joints. After the tool joint has been removed, clean the pipe threads and seals thoroughly and in-





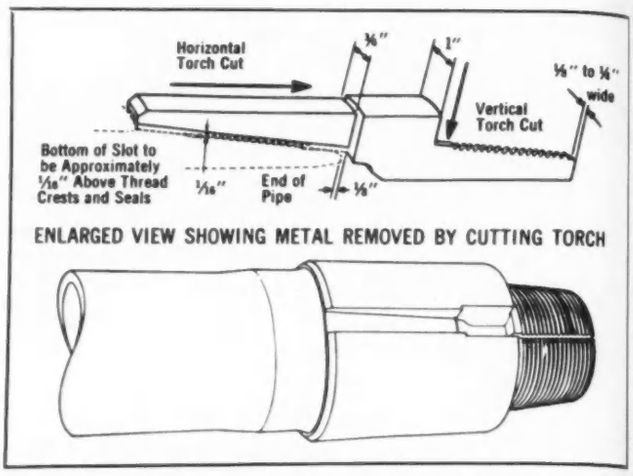


FIGURE 3—(Upper left) A "double seal" shrink thread tool joint is so named because of the outer and inner seal as illustrated.

FIGURE 4—(Upper right) Here is a tool joint and the recommended cutting dimensions while using the torch cutting method.

FIGURE 5—(Left) The recommended temperature, and cooling spray set-up is shown while using the heating and quenching method of removing tool joints.

spect for damage. File all burrs, deep scores, and remove all grease and foreign matter from the new or salvaged tool joint. Extreme care should be exercised to make certain that the tool joint has been thoroughly cleaned.

The tool joint should then be screwed on to the drill pipe by hand, making sure that there is no lubrication on either the tool joint or drill pipe. Further tightening of the tool joint should be accomplished with a chain-type coupling wrench.

A lengthwise mark should be placed on the outer surface of the tool joint in line with the stamped letter "C" on the pipe.

With a pencil or sharpened crayon point held closely against the face of the tool joint, mark a circumferential line, 2 or 3 inches long, on the machined surface of the drill pipe. This line enables the operator to gage the proper axial advance when applying the hot tool joint to the pipe.

Each pipe end and corresponding tool joints must be marked with identical numbers in order to prevent mismatching of pipe ends and tool joints during the shrinking on operation.

Applying double seal tool joints. The pipe should be positioned with chain tongs so that the stamped letters "H" and "C" are visible on top of the pipe. The tool joint should be removed and placed in a portable furnace and heated to 800° F.

The outer seal and the thread portion should not exceed 800° F. while the inner seal area should not exceed 700° F.

TABLE 1—These data are used for advancing shrink thread tool joints on drill pipe

Size, Inches	Type of Joint	Circumference of Machined Upset, Inches	Distance Between Hot & Cold, Inches	Circumferential Advance Cold to Hot Position, Inches
2⅞	Internal Flush	10.241	5.326	4.915
3½	Full Hole	11.278	6.316	4.962
3½	Internal Flush	12.206	5.616	6.590
4	Full Hole	12.865	5.661	7.204
4	Internal Flush	14.436	5.198	9.238
4½	Full Hole	14.436	5.198	9.238
4½	Extra Hole	14.436	5.198	9.238
4½	Internal Flush	15.855	5.073	10.782
5	Extra Hole	16.053	5.137	10.916
5½	Full Hole	17.778	3.911	13.867
5½	Internal Flush	19.273	2.313	16.960

With the aid of the tool joint holder, screw the hot unlubricated joint on to the unlubricated pipe to its former cold position. (Face of tool joint should be flush with the circumferential line on the pipe and the mark on the tool joint should be aligned with the stamped "C" on the pipe. Continue make-up until the mark on the tool joint is in line with the stamped "H" on the pipe. In this final position, the tool joint will cover the circumferential line on the pipe. (See Table 1 for exact make-up in the event the stamped "H" and "C" are obliterated.)

Loosen and remove the tool joint holder. Sufficient cooling will occur in approximately 15 seconds to shrink the joint to the pipe. Tightness can be judged by listening for a change in tone while tapping the joint lightly with a hammer. When tight, the reverberation changes from a dull to a sharp ringing sound.

The pipe seals are occasionally damaged with the cutting torch while removing the old tool joint. A new tool joint should not be applied until the damage has been repaired. Cuts or nicks should be filled with a brazing metal or silver solder and filed to the original contour. The contour accuracy may be judged by applying a cold tool joint with blued seals hand-tight on the pipe, and the mating condition determined by inspection of the blueing that has transferred to the repaired surface. —**The End**

How external casing corrosion is being controlled in East Texas

By M. J. Olive
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Operators have found cathodic protection to be the most practical and economical solution to the serious problem of external casing corrosion in the East Texas field. Casing corrosion to date has cost more than $3 million in the field even though most leaks occur at relatively shallow depths (0-500 feet) and are repaired at an average cost of $2,500 each.

Rectifiers generally are used as the means of applying the required minimum 2 amps current to each well. Both multiple and single well rectifier installations have been used and more than 450 wells now are protected in this manner. Although it is not feasible to protect every well in the field, leases experiencing high corrosion rates should be protected for economical production.

East Texas operators spent more than a quarter million dollars repairing casing leaks in 1958. There are more than 19,500 oil wells in the East Texas field and almost every well will develop one or more external casing leaks during its productive life unless casing corrosion is controlled. It is estimated that this annual expense will reach one half million dollars by the end of 1968.

At present, 3.4 billion barrels of oil have been produced from this field and another 2 billion barrels will be produced before the field is abandoned. To produce this oil at the present schedule, wells will have to last for another 40 to 50 years. Therefore, it is very important that operators keep casings intact during the productive life of the wells.

Effect of casing corrosion. External casing corrosion is field-wide and is not confined to any certain area. However, records of casing leaks from major companies representing 65 percent of the total wells have indicated that the south end of the field has the highest cumulative leak rate—165 leaks per 1,000 wells. The extreme north end has the next highest rate of 83 leaks per 1,000 wells. This can be seen in Figure 1.

Since 1932, there have been more than 1,350 leaks, which means that 69 out of every 1,000 wells have developed leaks. If this frequency is plotted against the date of occurrence and projected for the next 10 years, by the

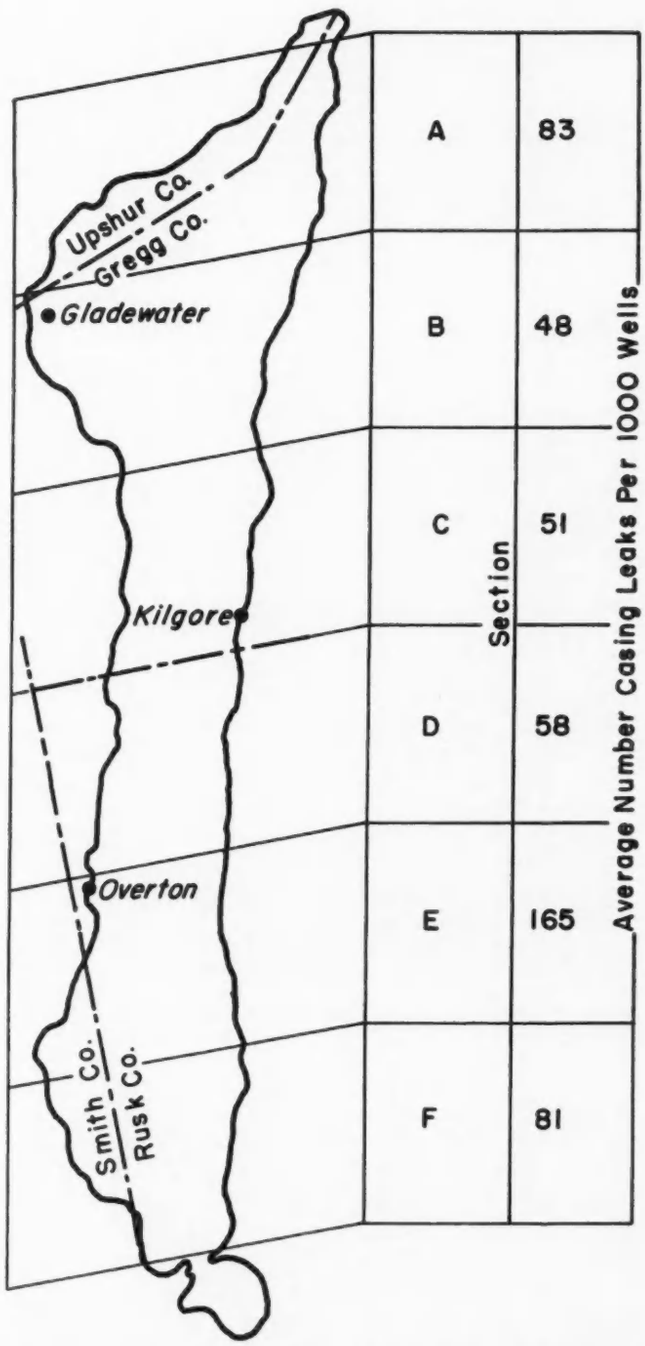

FIGURE 1—These figures, taken from a survey of the East Texas field, show how leak frequency can vary from one portion of the field to another. For example, an operator with 1,000 wells in Section E will have experienced 165 casing leaks to date. These data are based on the entire area average.

2,400 leaks by '68 . . .

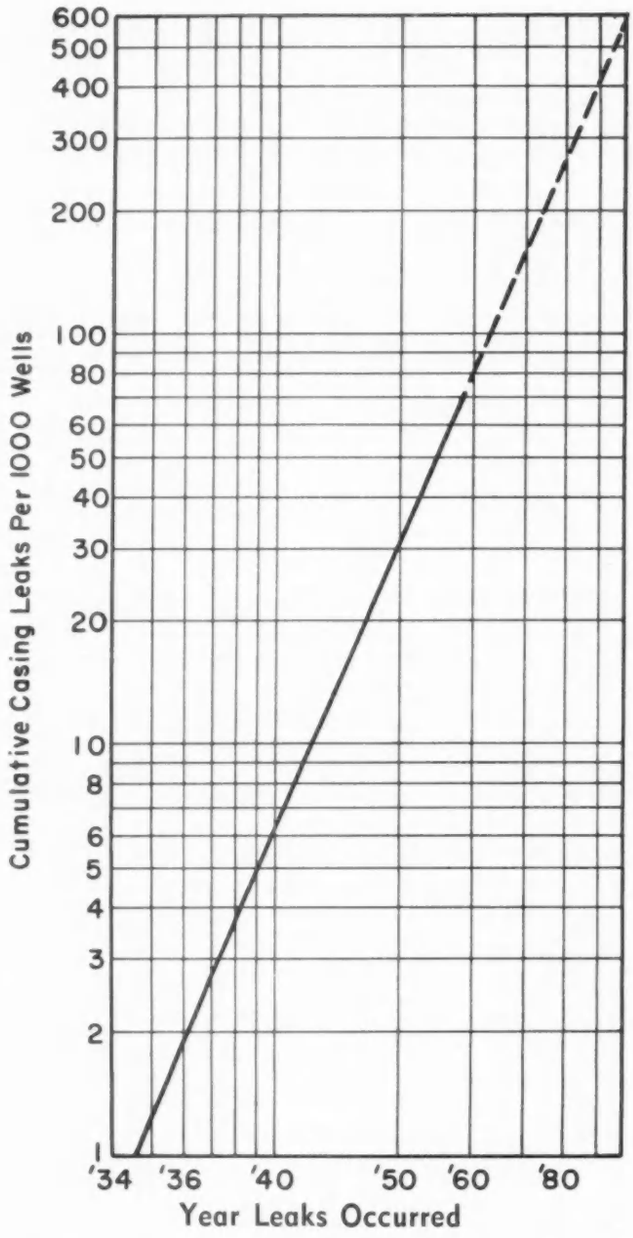

FIGURE 2—Future leak rates can be estimated by extrapolating this curve. Data such as these can be used for studies of the entire field.

Where leaks occur . . .

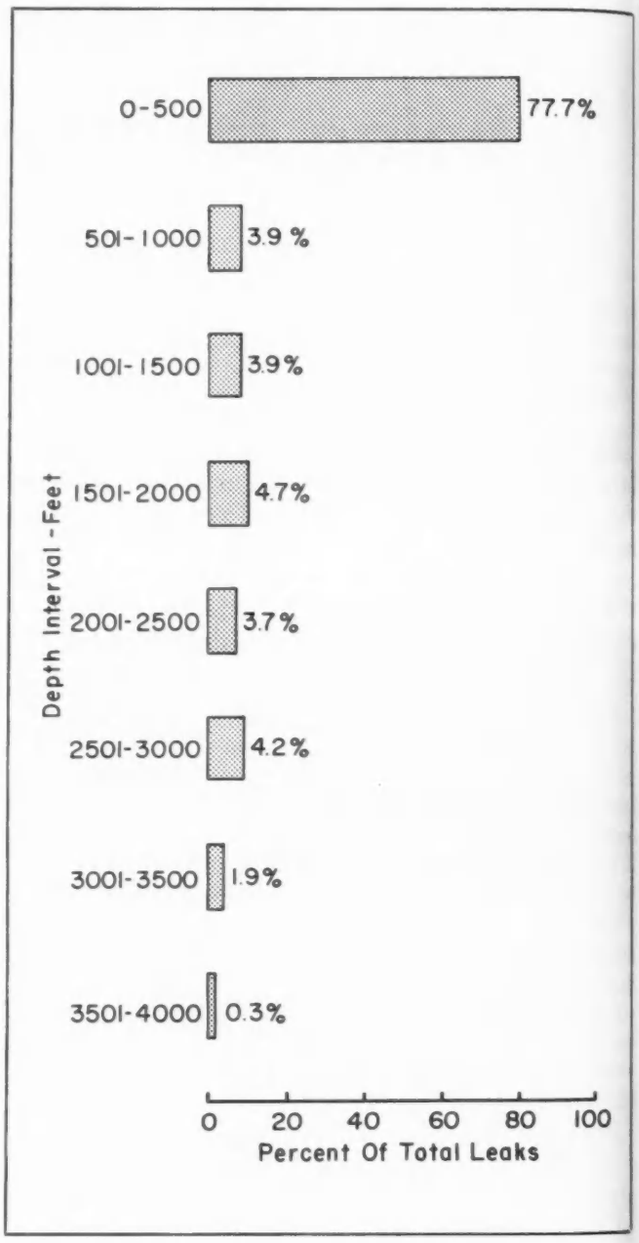

FIGURE 3—Almost 78 percent of all reported leaks occur within the upper 500 feet of casing strings. Leaks inside surface pipe are rare.

end of 1968 total leaks will exceed 2,400 (Figure 2).

These same records shown that almost 78 percent of the casing leaks occur in the upper 500 feet of the string (Figure 3). There have been only a few leaks reported inside surface pipe. These are considered exceptions.

Inspection of abandoned well casings further substantiates that heavy corrosion damage occurs below the surface pipe to a depth of 500 feet. Below 500 feet mild corrosion and isolated pitting occurs. In areas of heavy metal loss, holes are noted from pin-hole size to 6-8 inches in diameter as seen in Figure 4. Collars are corroded to a point where it is hard to distinguish them from pipe as shown in Figure 5. There are exceptions to this as some wells pulled show only mild corrosion; however, they are in the minority.

Causes of corrosion. Most operators agree that corrosion is caused by a combination of:

- Acidic water attack
- Dissimilar resistivity cell attack
- Bacteria attack
- Stray-current effect

Photographs show heavy corrosion damage . . .

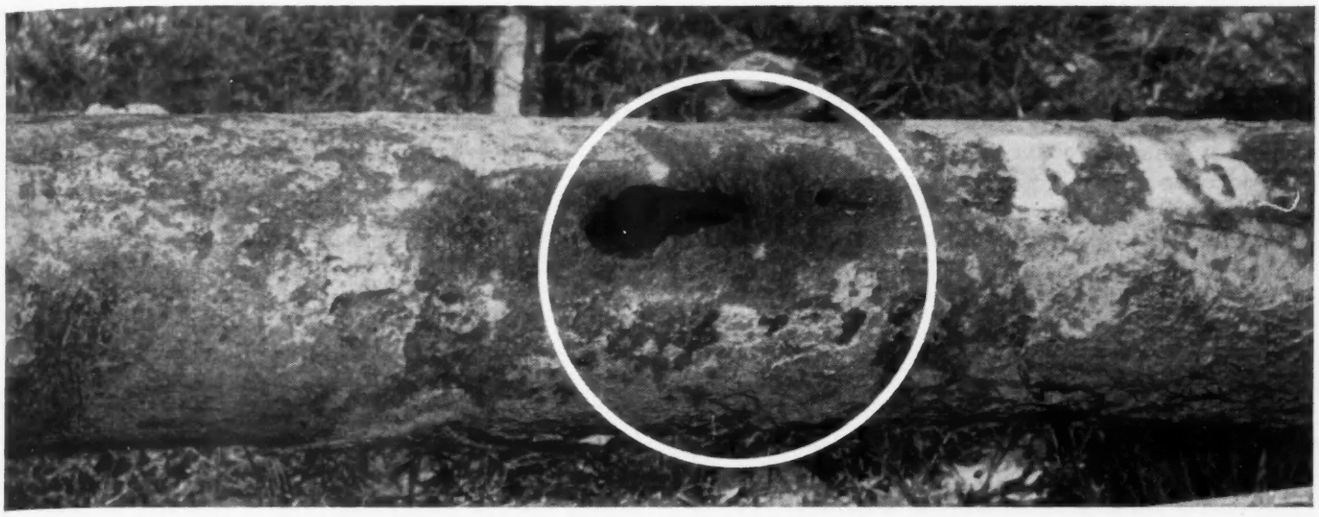

FIGURE 4—This joint of casing was recovered from an East Texas well on abandonment. The pipe is completely corroded around 80 percent of its circumference. The large 6 to 8-inch hole is typical of those found in the upper 500 feet of the string.

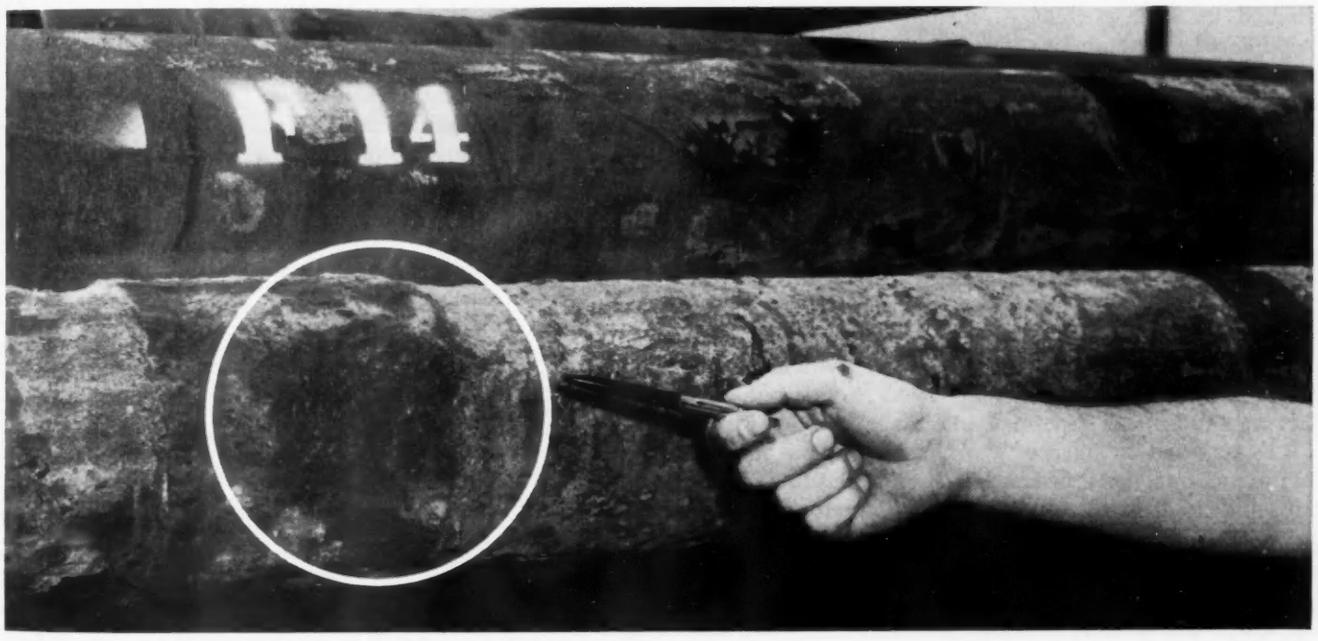

FIGURE 5—This section of casing shows severity of corrosion problem in East Texas. Collars are almost indistinguishable from the pipe itself. The other joint of pipe was pulled from inside surface pipe and shows no corrosion. Pipe also was in good condition below 500 feet.

Although any one of these can cause serious metal loss and casing leaks, the combined effect of all four contributes to the severity of the corrosion. A study of well logs and drilling data shows that from the surface to 500 feet there are many high and low-resistivity stratas which cause dissimilar soil corrosion cells. This study correlates with leak records and casing reclaim information.

Bacteria attack may contribute to the severity of localized pitting. Casing strings from abandoned wells have been shown to contain black algae type deposits and scale high in iron sulfide. One operator has grown active sulfate-reducing bacteria from scale removed from an abandoned well casing string. This bacteria forms hydrogen sulfide which, in turn, converts to an acid. This acid reacts with iron in the casing resulting in deep pitting and metal loss.

Some operators have run electrical tests and have found that current is being picked up on flow lines, tank bottoms and pipe lines. This current, which accelerates existing corrosion cells and adds to the problem of corrosion control, flows into the well discharging from the casing. This

cause of corrosion can be eliminated by isolating the well from its equipment by means of insulating flanges or unions. A few operators have started a program of insulating every well.

Cost of corrosion. Four methods are used in repairing casing leaks in the field: setting tubing packers, squeeze cementing, running patch tools, or setting short liners. Although setting a tubing packer is not a true casing repair, it is a method of preventing water from entering the production string. The cost of these repairs ranges from $500 to set packers to $3,500 and up for short liners, with the average cost about $2,500 per leak.

During 1958, 103 casing leaks were repaired at an estimated cost of $267,500 to the field operators. Unless some corrosion-prevention program is started, this annual cost will exceed $500,000 within 10 years and $750,000 within 20 years.

Corrosion-control methods used. A few operators have tried spotting mud high in alkalinity behind the casing during workovers or pumping the mud from the surface with pressure pumps. Because of limited success, this method has not been used except on an experimental basis. On these wells, corrosion prevention was successful only as long as the mud was in contact with the pipe and retained its high content of alkalinity. Difficulty was encountered in obtaining 100 percent coverage of the casing. If the casing was not completely covered, corrosion then was accelerated at the exposed points. Also, it is possible to collapse the casing during pumping if corrosion has weakened the steel.

Cathodic protection has been accepted as the most economical method of corrosion control. The cathodic protection process prevents corrosion by making the earth more positive than the steel casing. In doing this, hydrogen is plated on the protected surface. The hydrogen gas passes through the earth to the surface. This formation of hydrogen leaves an abundance of hydroxyl ions resulting in an alkaline environment. Since sulfate-reducing bacteria multiply or live in a pH range of 5 to 8 and will be retarded or killed at a pH of over 9, the alkaline environment prevents the bacteria from generating hydrogen sulfide and corrosion is controlled. Therefore cathodic protection can prevent both concentration-cell action and bacteria attack if sufficient current is supplied.

Cathodic protection current needed. In pipe line work current densities of 0.002 to 0.003 amperes per square foot are needed for corrosion prevention. However, in well-casing protection, this criteria cannot be used. The amount of current required to prevent corrosion normally is determined by down-hole potential surveys and surface-potential measurements. In the East Texas field, down-hole surveys appear to be the most reliable method. This method measures the potential drop in the casing as increasing amounts of current are applied. As the corrosion cells are eliminated, the potentials taken will indicate when corrosion currents leaving the casing have been offset by the cathodic protection current from the rectifier. This amount of current is the minimum required to stop large corrosion cells. Therefore, some extra current is required to eliminate small corrosion cells which the down-hole survey could miss.

Current required for East Texas wells, as determined by this method, is from 1.5 to 2.0 amperes. This will erase all cells down to the 500-foot level where 78 percent of all leaks occur, and will retard corrosion to total depth. Nearly every operator who has applied cathodic protection has designed the units on a 2-ampere requirement.

The surface-potential method has substantiated the down-hole method; but because of the complex underground pipe line system and close proximity of wells, use of the method has been limited.

Type and amount of cathodic protection used. Rectifiers utilizing graphite rods as ground beds have been used almost exclusively to apply current to well casing in East Texas.

Cathodic protection has been applied to 459 wells using 332 rectifiers. Half of the companies are using two or more wells per rectifier with the others using single-well installations. All have used an average of 4 anodes per unit with rectifier voltages up to 40 volts.

An average unit consists of a small 4 or 10-ampere rectifier with voltage steps up to 35 volts. Rectifiers are mounted on poles at the well on single units or at the ground bed on multiple-well units. On electrified leases 3-phase 440-volt rectifiers are installed, and on flowing leases single-phase 120-volt units are used. All wells are insulated from the flow line and other equipment as close to the christmas tree as practical by means of insulated unions or special flanges.

Surface soil resistivities generally are high with few leases having soils below 2,000 ohms per cubic centimeter. Old drilling-mud pits can be found, but these usually have resistivities from 4,000 to 8,000 ohms per cubic centimeter. On leases where water is being produced there usually is enough spillage or drains to give favorable soil conditions for good ground beds. However, many leases will not have conditions suitable for conventional cathodic-protection ground beds, and will require deep ground-bed installations before current can be applied to well casings.

Cost and economics of cathodic protection. Average rectifier and ground-bed installation cost is $460, and the average cost per well is $300. Based on present installations, annual operating and maintenance expense is $12 per well. Therefore, depreciating the cathodic protection

About the Author

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unit over a 20-year period and considering salvage offset by major replacements, the depreciation, operating and maintenance expense will result in a yearly cost of about $30 per well (Table 1).

TABLE 1—Estimated Expense of Cathodic Protection East Texas Field

Material:			
Rectifier 18-volt 10-amp or 36-volt 10-amp	$125.00		
6–3 x 60 graphite anodes @ $9.90	60.40		
2,000-lb coke backfill @ $56.00 per ton	56.00		
400 ft #8 CP copper cable @ $101.00 per 1000	40.40		
Miscellaneous fittings	28.00		
		$309.80	
Labor–4 men 1 day each @ $20.00 per day		80.00	
Auto and truck		20.20	
Engineering and supervision		50.00	
			$460.00
Cost per well			$230.00
Estimated power cost based on present cost of units @ $1.50 per month per well			
Yearly cost			$ 18.00
Yearly cost of cathodic protection per well:*			
Initial cost depreciated @ 20 years		$ 11.50	
Power cost		18.00	
			$ 29.50

* Assuming maintenance repairs to offset the salvage value of the unit in 20 years.

For example, if an operator had 1,000 wells, it would cost $30,000 per year to install and operate cathodic protection. Over the next 10 years, it would cost $300,000. Corrosion would cost $181,250 in the same period based on the over-all leak average of the field. Over-all field corrosion cost is not great enough to justify total protection of the field (Figure 6). However, in Section E (Figure 1) where as high as 16 leaks per 1,000 wells are occurring per year, the saving by cathodic protection could be in the range of $300,000 before wells are abandoned. In Section B, a leak rate of 3 per 1,000 wells per year is indicated. Therefore, cathodic protection in this area is not economical. Each operator should determine what corrosion is costing him, lease by lease, and section by section, and then compare this cost with the cost of cathodic protection (Table 2).

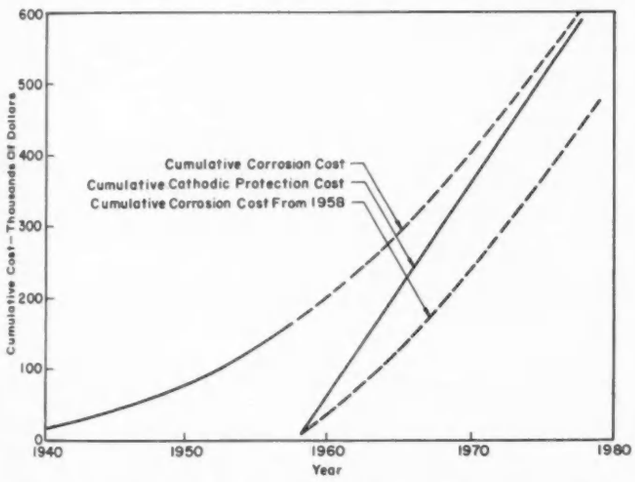


FIGURE 6—If cathodic protection is applied to all wells in 1959, cumulative corrosion costs will not exceed cumulative cathodic protection costs by 1985. This is based on an estimated per well casing leak repair cost of $2,500 and 1,000 wells. Because of leak frequency variations, it is obvious that cathodic protection installations should be considered only for given areas. For example, it would not be economical to install cathodic protection in Section B (Figure 1) due to the low leak frequency of three per 1,000 wells.

TABLE 2—Cumulative Corrosion Cost Versus Cumulative Cathodic Protection Cost

Year	Cumulative Leaks/1000 Wells	Yearly Cost	Cumulative Corrosion Cost	Cumulative Cathodic Protection Cost @ $30/Well/Year	Cumulative Corrosion Cost From 1959
1932	.1	$ 250	$ 250	.....	.....
1933	.3	500	750	.....	.....
1934	.5	500	1,250	.....	.....
1935	.8	750	2,000	.....	.....
1936	1.7	2,250	4,250	.....	.....
1937	2.4	1,750	6,000	.....	.....
1938	3.3	2,250	8,250	.....	.....
1939	4.3	2,500	10,750	.....	.....
1940	6.7	6,000	16,750	.....	.....
1941	8.7	5,000	21,750	.....	.....
1942	10.2	3 750	25,500	.....	.....
1943	11.1	2,250	27,750	.....	.....
1944	13.5	6,000	33,750	.....	.....
1945	15.5	5,000	38,750	.....	.....
1946	18.1	6,500	45,250	.....	.....
1947	20.6	6,250	51,500	.....	.....
1948	23.8	8,000	59,500	.....	.....
1949	27.8	10,000	69,500	.....	.....
1950	31.6	9,500	79,000	.....	.....
1951	34.9	8,250	87,250	.....	.....
1952	38.3	8,500	95,750	.....	.....
1953	43.0	11,750	107,500	.....	.....
1954	47.4	11,000	118,500	.....	.....
1955	51.4	10,000	128,500	.....	.....
1956	56.9	13,750	142,250	.....	.....
1957	63.9	17,500	159,750	.....	.....
1958	69.2	13,250	173,000	.....	.....
1959	75.2	15,000	188,000	$ 30,000	$ 15,000
1960	81.4	15,500	203,500	60,000	30,500
1961	87.9	16,250	219,750	90,000	46,750
1962	94.8	17,250	237,000	120,000	64,000
1963	101.9	17,750	254,750	150,000	81,750
1964	109.2	18,250	273,000	180,000	100,000
1965	116.9	19,250	292,250	210,000	119,250
1966	124.9	20,000	312,250	240,000	139,250
1967	133.1	20,500	332,750	270,000	159,750
1968	141.7	21,500	354,250	300,000	181,250
1969	150.6	22,250	376,500	330,000	203,500
1970	159.6	22,500	399,000	360,000	226,000
1971	169.0	23,500	422,500	390,000	249,500
1972	177.5	21,250	443,750	420,000	270,750
1973	188.5	27,500	471,250	450,000	298,250
1974	199.6	27,750	499,000	480,000	326,000
1975	210.0	26,000	525,000	510,000	352,000
1976	220.0	25,000	550,000	540,000	377,000
1977	230.0	25,000	575,000	570,000	402,000
1978	245.0	37,500	612,600	600,000	439,500

Summary. Most operators believe that corrosion is caused by acidic waters, bacteria, dissimlar soils, and stray current effects. Seventy-five percent of all casing leaks occur within 500 feet of the surface. 1,350 total leaks were reported through 1958, and it is estimated that 2,400 will occur by the end of 1968. Cathodic protection is the most economical approach to corrosion control. The average cost of cathodic protection is $30 per year per well which includes power cost, depreciation and maintenance. The average cost of a rectifier unit is $460. There have been 332 rectifiers installed for protection of 459 wells. The average requirement is 2 amperes with rectifiers operating up to 40 volts. Corrosion is costing from $7.50 to $40 per year per well. Field-wide corrosion control by cathodic protection is not economically feasible at the present time, based on available data of corrosion cost and protection expenses. Many leases, however, are experiencing corrosion so severe that prevention is necessary for economical operation.

Each operator must evaluate his corrosion cost and his anticipated corrosion cost, and then compare this cost with cathodic-protection expenses.

This article is based on a paper entitled "External Casing Corrosion and Prevention in the East Texas Field" which was presented at the 1959 Southern District meeting, API Division of Production, New Orleans.

—The End

Supply company dilemma

Industry purchases are up—suppliers' profits are down

During the first quarter, purchases of oil country goods increased 36.9 percent over the same 1958 period

DESPITE TWO drilling activity deterrents, oversupply of crude and excessive productive capacity, purchases of oil country goods are expected to increase 5 to 10 percent during 1959. However, the pattern of slim supply company profits set in 1958 (22 companies had an average of .35 percent of net sales) are expected to continue into 1960, with a possibility of slight improvement.

Drillers and producers set the pace for a substantial increase in purchases with a heavy buying spurt during the first quarter. According to a recent survey by Price Waterhouse and Company, oil industry purchases from 26 supply companies totaled $202.8 million, 36.9 percent greater than the $148.1 million reported for the first quarter of 1958.

Purchases of tubular products, which account for 40-55 percent of supply company business, totaled $97.1 million during the first quarter, up 94.7 percent over the same 1958 period. Non-tubular goods purchases were up 7.6 percent to a total of $105.7 million.

A WORLD OIL survey reveals the following reasons for a predicted increase in purchases of tubular and non-tubular goods this year:

- Improved business conditions, including tighter import controls, increased demand for oil and gas products, and a substantial increase in oil company profits.
- Rig activity, though still far below the peak years of 1956-57, is up from 1958.
- After living off of stocks during the tight recession months of 1958, oil companies started rebuilding inventories early this year.
- Some companies are stockpiling oil country goods in anticipation of a possible steel strike this summer. Others are protecting inventories by using in-transit goods to save their tangible stocks.

These factors are expected to override the oversupply and excessive productive capacity deterrents, and lead the way to a better sales year for supply companies, though total volume still will be considerably below the records set in 1956-57.

As a result of the heavy buying during the first and second quarters, purchases will taper off during the second half of the year, particularly in tubular goods. If there is a steel strike, purchases will drop off even more sharply with the resulting shortage of materials.

Why profits are down. Supply company officials point out several reasons for their poor profit showing during 1958: (1) The recession forced supply companies to pare profits to get a share of the business. This competitive situation is expected to continue for quite some time. (2) Cost of goods supply companies manufacture went up, but not the prices.

(3) As a result of stepped up competition, profit margins decreased on goods for other manufacturers. (4) Because of the many idle rigs, a comparatively small number of major machinery items were sold. (5) Supply company profits on rock bits were reduced from 10 percent to 7.5 percent after a price cut on May 1, 1958.

However, some supply company spokesmen are more optimistic about the future than others. They believe the profit picture may improve this year through more efficient operations resulting from economies adopted during the recession, and the expected increase in oil industry purchases during 1959.

Purchases of Tubular Goods Increased 94.7 Percent in First Quarter

Material	No. of Cos. Reporting	FIRST QUARTER SALES 1959	FIRST QUARTER SALES 1958	Percent Change
Tubular Products:				
a. Oil country goods	13	$ 67,993,000	$ 31,440,000	+116.3
b. Line pipe, except continuous weld	12	4,906,000	2,610,000	+ 87.9
c. Continuous weld	10	5,300,000	3,647,000	+ 45.3
d. All other pipe	9	2,224,000	1,943,000	+ 14.5
e. Detail not reported	13	16,641,000	10,216,000	+ 62.9
Total tubular products	26	**97,064,000**	**49,856,000**	**+ 94.7**
Non-Tubular Products:				
a. Rock bits	11	13,104,000	14,348,000	— 8.7
b. Pumping units	11	4,828,000	4,507,000	+ 7.1
c. Sucker rods	11	5,035,000	4,227,000	+ 19.1
d. Sub-surface pumps and parts	11	4,957,000	4,526,000	+ 9.5
e. Drilling equipment	8	6,340,000	4,149,000	+ 52.8
f. Wire rope	11	1,908,000	1,687,000	+ 13.1
g. All other non-tubular	11	50,844,000	46,441,000	+ 9.5
h. Detail not reported	14	18,679,000	18,382,000	+ 1.6
Total non-tubular products	25	**105,695,000**	**98,267,000**	**+ 7.6**
Total net sales	26	**202,759,000**	**148,123,000**	**+ 36.9**

* 1959 reports included revised amounts for 1958.

How to plan a directional well

By John B. Buchanan
University of Oklahoma, Norman

The basic fundamental terminology and calculations of a directional drilling operation, must first be understood prior to planning the projected hole:

- The kickoff point, or KOP, is the depth at which the original deviation of the hole is begun (Figure 1).
- Deviation or throw is the horizontal distance between two survey points or between the surface location and any point in the well.
- The drift angle is the angular deviation of the hole from vertical.
- The rate of increase of the drift angle is known as the drift angle buildup and is expressed as the number of degrees increase for a certain drilled footage; for example, 2 degrees per 100 feet.
- True vertical depth, or TVD, is the actual below-surface depth as compared to the measured drilling depth, or MD.
- Closure is the distance and direction, in a horizontal plane, of the bottom of the hole from the surface location (Figure 2).
- The target is the objective of the directional well, usually square or rectangular in shape.

Tables similar to Tables 1 through 4 are useful in the planning of directionally drilled wells.

The following problem has been prepared to illustrate the basic calculations involved in planning a directional drilling operation. Figure 3 is a plot of the results obtained from the solution of the problem.

DATA

The bottom-hole objective of this well is a 400-foot square with the center 2,735.7 feet N79°28′E of the surface location. This square must be

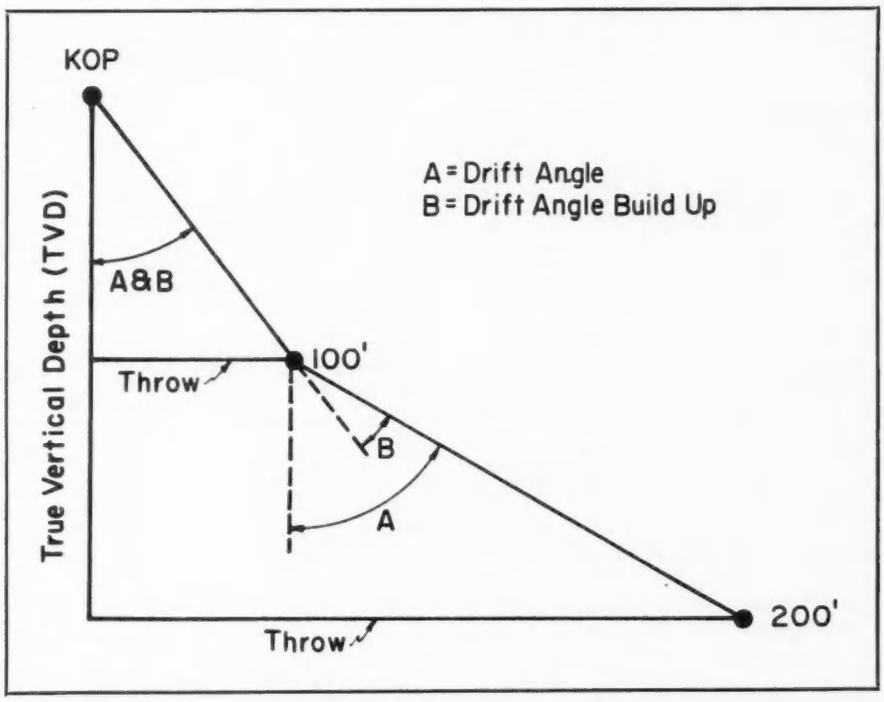


FIGURE 1—Schematic presentation of terms used in drilling a directional well.

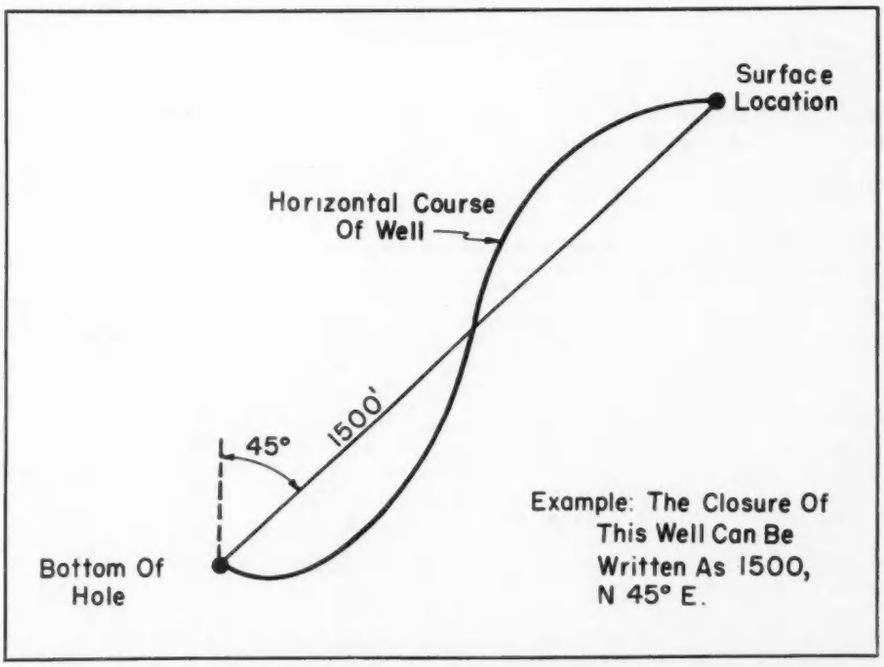

Surface Location
Horizontal Course Of Well
45°
1500'
Example: The Closure Of This Well Can Be Written As 1500, N 45° E.
Bottom Of Hole

FIGURE 2—The closure of this directional well can be described as a horizontal distance of 1,500 feet N 45 degrees E from the surface location to the bottom of the hole.

penetrated at a depth of 8,300 feet TVD, and the hole must be controlled within this area to a total depth of approximately 10,700 feet TVD.

Proposed casing program

16 -inch @ 150 feet in 22-inch hole
10¾-inch @ 1,800 feet in 15-inch hole
7 -inch @ 11,700 feet in 9⅞-inch hole

Company policy and experience indicate that a maximum drift angle of 25 degrees may be attained.

PROBLEM

Develop a directional drilling plan.

SOLUTION

Consideration of maximum drift angle. Determine the throw, TVD, and MD for a drift-angle build-up of 2½ degrees per 100 feet of hole drilled to a maximum of 25 degrees. From Table 2:

1. Throw = 235.81 feet
2. TVD = 963.72 feet
3. MD = 1,000.00 feet

Consideration of return-to-vertical portion of the hole. Determine the throw, TVD, and MD for starting the hole back to vertical from 25 degrees at the rate of 2 degrees per 100 feet of hole drilled until a drift angle of 10 degrees is reached. From Table 1:

1. Throw = 237.69 feet
2. TVD = 709.06 feet
3. MD = 750.00 feet

Then determine the throw, TVD, and MD for bringing the hole back to vertical from 10 degrees at the rate of 1 degree per 100 feet of hole drilled. From Table 4:

1. Throw = 95.73 feet
2. TVD = 994.14 feet
3. MD = 1,000.00 feet

Consideration of the constant-angle portion of the hole. After the previous calculations, 2,166.47 feet of throw remain to be accounted for.

From Table 2, an angle 25 degrees will give a throw of 42.26 feet per 100 feet of hole drilled. Dividing the remaining 2,166.47 feet of throw by .4226, the measured depth remaining to be drilled is 5,126.53 feet.

Also from Table 2, drilling at an angle of 25 degrees will result in 90.63 feet of true vertical depth per 100 feet of hole drilled. Multiplying the 5,126.53 feet of MD by .9063, the TVD will be 4,646.17 feet.

1. Throw = 2,166.47 feet
2. TVD = 4,646.17 feet
3. MD = 5,126.53 feet

Summation of results

1. Total Throw = 2,735.70 feet
2. Total TVD = 7,313.09 feet
3. Total MD = 7,876.53 feet

Determination of KOP. A total of 7,313.09 feet of TVD has been ac-

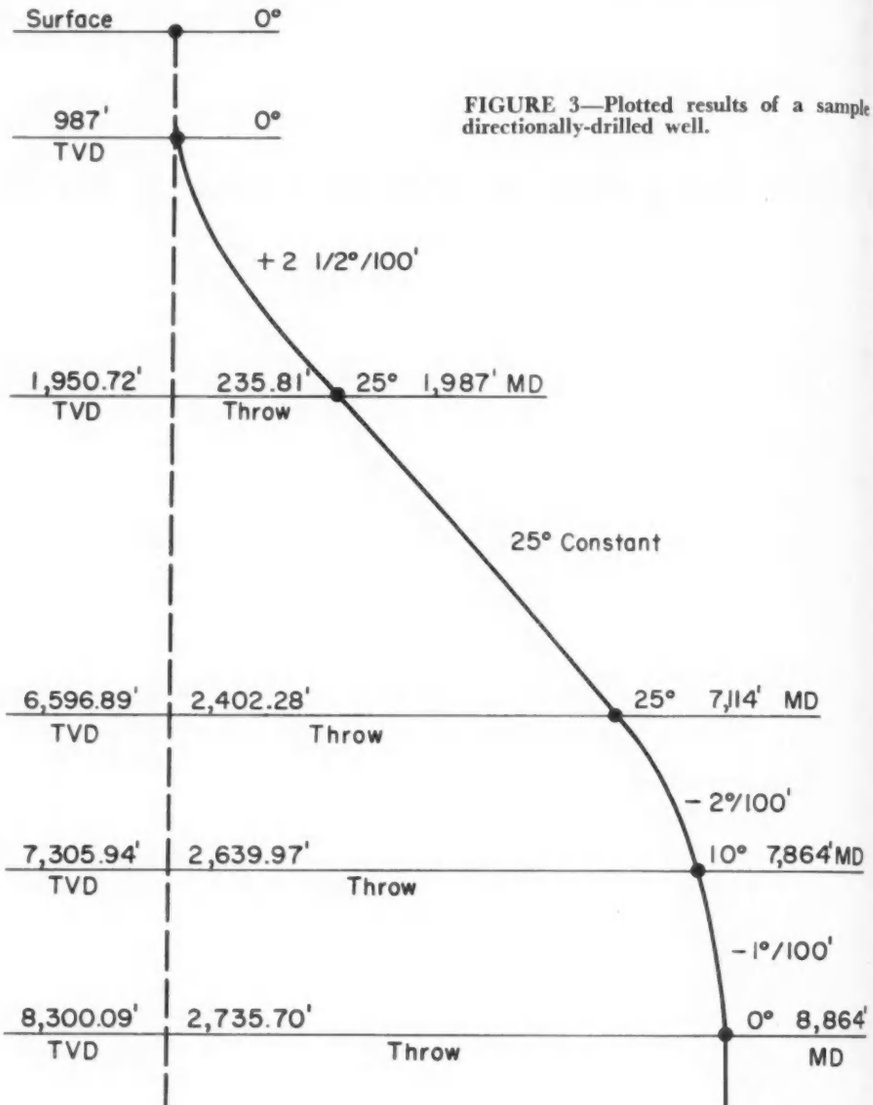


FIGURE 3—Plotted results of a sample directionally-drilled well.

TABLE 1—This Table Is Used to Determine the Maximum Buildup Throw of a Well In Any Direction When the Drift Angle Is Built Up At the Rate of 2 Degrees per 100 Feet

Depth-ft.	Angle-degrees	Throw-ft.	Cum. Throw-ft.	TVD Correction-ft.	Cum. TVD-ft.
KOP	0	0	0	0	0
+ 100	2	3.49	3.49	99.94	99.94
+ 200	4	6.98	10.47	99.76	199.70
+ 300	6	10.45	20.92	99.45	299.15
+ 400	8	13.92	34.84	99.03	398.18
+ 500	10	17.36	52.20	98.48	496.66
+ 600	12	20.79	72.99	97.81	594.47
+ 700	14	24.19	97.18	97.03	691.50
+ 800	16	27.56	124.74	96.13	787.63
+ 900	18	30.90	155.64	95.11	882.74
+1,000	20	34.20	189.84	93.97	976.71
+1,100	22	37.46	227.30	92.72	1,069.43
+1,200	24	40.67	267.97	91.35	1,160.78
+1,300	26	43.84	311.81	89.88	1,250.66
+1,400	28	46.95	358.76	88.29	1,338.95
+1,500	30	50.00	408.76	86.60	1,425.55
+1,600	32	52.99	461.75	84.80	1,510.35
+1,700	34	55.92	517.67	82.90	1,593.25
+1,800	36	58.78	576.45	80.90	1,674.15
+1,900	38	61.57	638.02	78.80	1,752.95
+2,000	40	64.28	702.30	76.60	1,829.55

TABLE 2—This Table Is Used to Determine the Maximum Buildup Throw of a Well in Any Direction When the Drift Angle Is Built Up At the Rate of 2½ Degrees per 100 Feet

Depth-ft.	Angle-degrees	Throw-ft.	Cum. Throw-ft.	TVD Correction-ft.	Cum. TVD-ft.
KOP	0	0	0	0	0
+ 100	2½	4.36	4.36	99.90	99.90
+ 200	5	8.72	13.08	99.62	199.52
+ 300	7½	13.05	26.13	99.14	298.66
+ 400	10	17.36	43.49	98.48	397.14
+ 500	12½	21.64	65.13	97.63	494.77
+ 600	15	25.88	91.01	96.59	591.36
+ 700	17½	30.07	121.08	95.37	686.73
+ 800	20	34.20	155.28	93.97	780.70
+ 900	22½	38.27	193.55	92.39	873.09
+1,000	25	42.26	235.81	90.63	963.72
+1,100	27½	46.17	281.98	88.70	1,052.42
+1,200	30	50.00	331.98	86.60	1,139.02
+1,300	32½	53.73	385.71	84.34	1,223.36
+1,400	35	57.36	443.07	81.92	1,305.28
+1,500	37½	60.88	503.95	79.34	1,384.62
+1,600	40	64.28	568.23	76.60	1,461.22

TABLE 3—This Table Is Used to Determine the Maximum Buildup Throw of a Well in Any Direction When the Drift Angle Is Built Up At the Rate of 3 Degrees per 100 Feet

Depth-ft.	Angle-degrees	Throw-ft.	Cum. Throw-ft.	TVD Correction-ft.	Cum. TVD-ft.
KOP	0	0	0	0	0
+ 100	3	5.23	5.23	99.86	99.86
+ 200	6	10.45	15.68	99.45	199.31
+ 300	9	15.64	31.32	98.77	298.08
+ 400	12	20.79	52.11	97.81	395.89
+ 500	15	25.88	77.99	96.59	492.48
+ 600	18	30.90	108.89	95.11	587.59
+ 700	21	35.84	144.73	93.36	680.95
+ 800	24	40.67	185.40	91.35	772.30
+ 900	27	45.40	230.80	89.10	861.40
+1,000	30	50.00	280.80	86.60	948.00
+1,100	33	54.46	335.26	83.87	1,031.87
+1,200	36	58.78	394.04	80.90	1,112.77
+1,300	39	62.93	456.97	77.71	1,190.48
+1,400	42	66.91	523.88	74.31	1,264.79
+1,500	45	70.71	594.59	70.71	1,335.50

TABLE 4—These Data Are Used to Return a Direction Hole to Vertical At the Rate of 1 Degree per 100 Feet

Depth-ft.	Angle-degrees	Throw-ft.	Cum. Throw-ft.	TVD Correction-ft.	Cum. TVD-ft.
	0	0	0	0	0
	1	1.75	1.75	99.98	99.98
	2	3.49	5.24	99.94	199.92
	3	5.23	10.47	99.86	299.78
	4	6.98	17.45	99.76	399.54
	5	8.72	26.17	99.62	499.16
	6	10.45	36.62	99.45	598.61
	7	12.19	48.81	99.25	697.86
	8	13.92	62.73	99.03	796.89
	9	15.64	78.37	98.77	895.66
	10	17.36	95.73	98.48	994.14
	12	20.79	116.52	97.81	1,091.95
	14	24.19	140.71	97.03	1,188.98
	16	27.56	168.27	96.13	1,285.11
	18	30.90	199.17	95.11	1,380.22
	20	34.20	233.37	93.97	1,474.19
	22	37.46	270.83	92.72	1,566.91
	24	40.67	311.50	91.35	1,658.26
	26	43.84	355.34	89.88	1,748.14
	28	46.95	402.29	88.29	1,836.43
	30	50.00	352.29	86.60	1,923.03
	32	52.99	505.28	84.80	2,007.83
	34	55.92	561.20	82.90	2,090.73
	36	58.78	619.98	80.90	2,171.63
	38	61.57	681.55	78.80	2,250.43
	40	64.28	745.83	76.60	2,327.03

counted for. The hole must be vertical at 8,300 feet. Subtracting the 7,313.09 feet from 8,300 feet, the KOP will be at approximately 987 feet.

Summary of directional drilling plan

1. Assume hole vertical at 987 feet MD.

2. Increase angle 2½ degrees per 100 feet from 987 feet to 1,987 feet MD (1,950.72 feet TVD).

3. Maintain average angle of 25 degrees from 1,987 feet MD to 7,114 feet MD (6,596.89 feet TVD).

4. Decrease angle 2 degrees per 100 feet from 7,114 feet MD to 7,864 feet MD (7,305.94 feet TVD).

5. Decrease angle 1 degree per 100 feet from 7,864 feet MD to 8,864 MD (8,300.09 feet TVD).

6. Deflect 2,735.7 feet N79°28'E of surface location at 8,300.00 TVD .

—**The End**

Down-hole plastic pipe installations draw interest

Continued from Page 92

important is the moduli difference between steel and reinforced plastic tubing. Hence, each well must be specifically designed. At this writing, the longest string of plastic pipe in a production well is 1,024 feet, but depths of 1,500-1,700 feet are possible under ideal operating conditions.

In many production wells, use of this tubing has eliminated rod trouble, since it apparently acts, in its nonconductor capacity, as an electrolytic barrier. In other wells, the frequency of rod failure has been materially lessened. The tubing has been used elsewhere because of its low thermal conductivity and smooth interior minimize paraffin deposition.

The author does not wish to portray reinforced plastic tubing as a panacea for the oil industry. Its lack of certain mechanical properties is one limitation. Economic considerations preclude its use in other applications. However, advantages of plastic pipe installations are apparent when applied to well types discussed here. This article is intended to inform the producing industry of another material of potential benefit in the control of surface and down-hole corrosion. —**The End**

About the Author

E. D. Edmisten graduated from the University of Tulsa with degrees in petroleum engineering and engineering physics. For 15 years he was employed by Stanolind Oil and Gas Co. (now Pan-American Petroleum Corporation) in the field and research center, Tulsa. In 1955, he was appointed quality control manager for Fibercast Company, a division of Youngstown Sheet and Tube Co., Sand Springs, Okla. He has been active in applications and production planning since that time. Memberships include ASTM, NACE, SPE and ASM.

Independents do much of the drilling in all areas

Smaller operators in 1958 drilled from 75 to 100 percent of wells in all but a few districts

By L. J. Logan, Associate Editor, WORLD OIL

MORE THAN 6,500 U.S. independent operators and smaller companies drilled almost 80 percent of all U.S. wells, and from 90 to 100 percent of the wells in numerous areas during 1958.

Independents drilled about 38,500 wells out of 48,341 completed in the country. This is indicated by the accompanying table based on the drilling reports of 22 major companies. The major companies drilled about 9,800 wells, or slightly over 20 percent of the U.S. total.

During 1958, from 95 to 100 percent of the drilling was done by independent operators in New York, West Virginia, Ohio, Kentucky, Indiana, Michigan and Alabama. In those states the wells are predominantly shallow, production is small, and drilling costs are moderate.

Under similar conditions, the independents drilled 90 to 95 percent of the wells in Pennsylvania, Arkansas, Kansas and North Texas. They drilled 85 to 90 percent of the wells in South Dakota, Colorado, North Louisiana, Eastern Texas and Southwest Texas, and 82 percent of those in Nebraska.

Independents drilled around 75 percent of the wells, or somewhat less than their national average ratio, in Illinois, Wyoming, New Mexico, the upper Texas Gulf Coast and the Texas Panhandle. They drilled only around 60 percent of the wells in Montana, Mississippi and California, where they were deterred by such factors as market conditions and drilling costs.

Big company areas. There are only a few areas where the independent operators drill fewer wells than the major companies. They include South Louisiana, North Dakota, Utah and West Texas.

Independents in 1958 drilled only 42 percent of the wells in South Louisiana. They are handicapped there by the large amount of capital required. The area has the deepest drilling in the country. It also has much drilling offshore, where even major companies usually drill jointly to hold down costs and risks.

Independents drilled only 46 percent of the wells in North Dakota, 31 percent of those in Utah, and 50 percent of those in West Texas. In those areas they are deterred by scarcity of promising acreage, deep and relatively expensive drilling, and limited market outlets for crude oil. Major companies, in contrast, have extensive choice leases, can finance costly development, and can wait longer for markets for crude.

—The End

Independent Operators Drilled Large Proportions of Wells in Majority of States in 1958

(Table is based on data reported by 22 larger companies)

STATE or DISTRICT	Total Wells Drilled	22 Major Companies*		Rest of Industry	
		Wells	% of Total	Wells	% of Total
Alabama	85	2	2.4	83	97.6
Arkansas	852	56	6.6	796	93.4
California	1,367	571	41.8	796	58.2
Colorado	850	116	13.6	734	86.4
Illinois	2,302	517	22.5	1,785	77.5
Indiana	891	46	5.2	845	94.8
Kansas	3,759	296	7.9	3,463	92.1
Kentucky	1,812	47	2.6	1,765	97.4
Louisiana	3,508	1,420	40.5	2,088	59.5
North Louisiana	1,389	196	14.1	1,193	85.9
South Louisiana	2,119	1,224	57.8	895	42.2
Michigan	392	17	4.3	375	95.7
Mississippi	428	165	38.6	263	61.4
Montana	306	116	37.9	190	62.1
Nebraska	697	126	18.1	571	81.9
New Mexico	1,970	498	25.3	1,472	74.7
New York	540	....	....	540	100.0
North Dakota	408	220	53.9	188	46.1
Ohio	988	3	0.3	985	99.7
Oklahoma	7,047	847	12.0	6,200	88.0
Pennsylvania	794	83	10.5	711	89.5
South Dakota	7	1	14.3	6	85.7
Texas	17,283	4,185	24.2	13,098	75.8
R.R. Comm. District—					
1: South Central	988	215	21.8	773	78.2
2: Middle Gulf	699	113	16.2	586	83.8
3: Upper Gulf	1,295	343	26.5	952	73.5
4: Lower Gulf-S.W.	1,128	170	15.1	958	84.9
5-6: East Central and North East	1,033	127	12.3	906	87.7
7B-9: North Central and North	5,874	377	6.4	5,497	93.6
7C-8: West Central and West	4,960	2,461	49.6	2,499	50.4
10: Panhandle	1,306	379	29.0	927	71.0
Utah	395	274	69.4	121	30.6
West Virginia	836	1	0.1	835	99.9
Wyoming	711	177	24.9	534	75.1
Other States†	113	11	9.7	102	90.3
Total United States	48,341	9,795	20.3	38,546	79.7

* Amerada, Atlantic, Carter, Cities Service, Continental, Gulf, Humble, Ohio, Pan American, Phillips, Pure, Richfield, Shell, Sinclair, Socony-Mobil (Magnolia and General), Standard of California (California Co. and Standard of Texas), Sun, Sunray Mid-Continent, The Texas Company, Tide Water, Union Oil of California and Union Producing.

† Alaska, Arizona, Florida, Georgia, Idaho, Maryland, Missouri, Nevada, Oregon, Tennessee, Virginia, Washington.

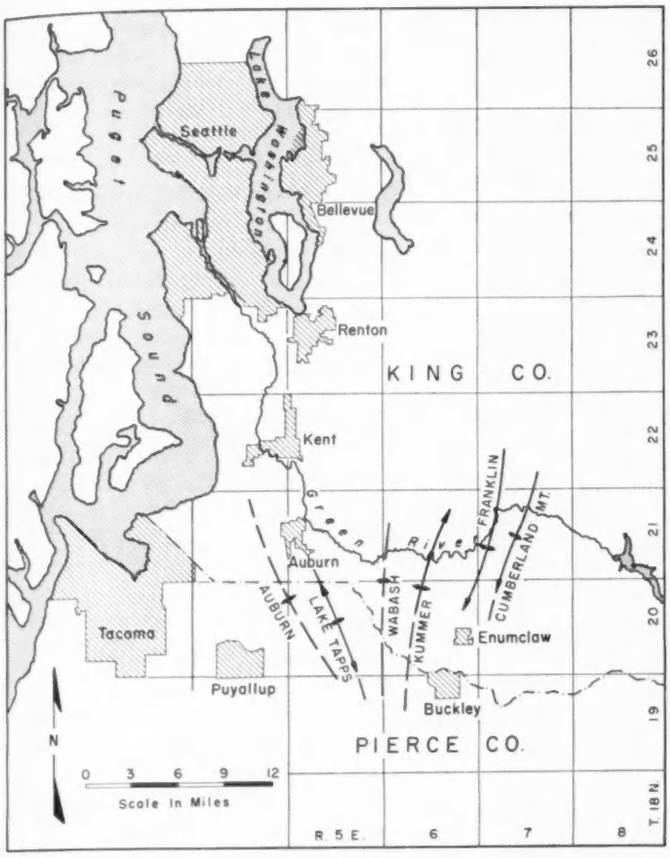


FIGURE 1—Index map of Green River district showing location of several anticlinal folds.

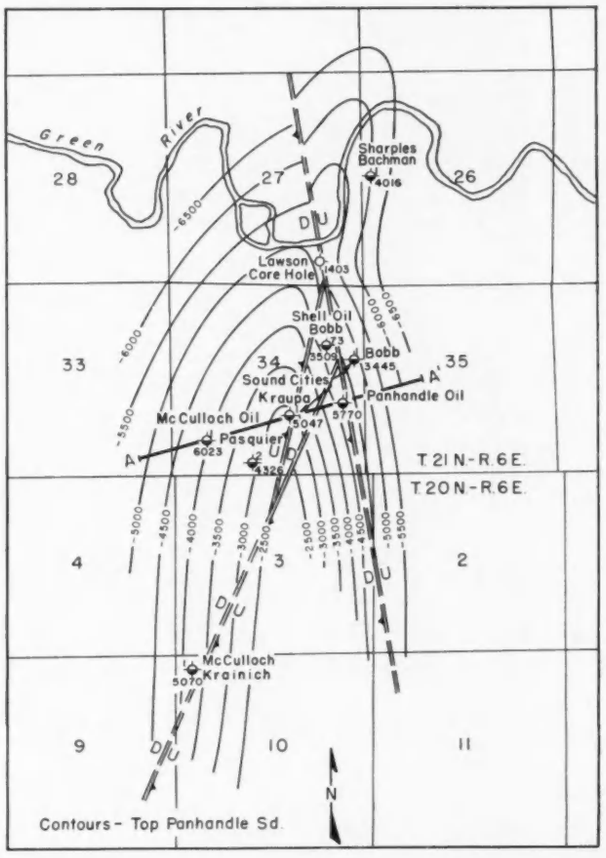


FIGURE 2—Structural contour map of northern portion of the Kummer anticline, showing indicated complex structure.

Puget Sound area has several prospective oil and gas basins

Great thicknesses of Upper Cretaceous and Tertiary sediments, large structures comparable to productive California areas

By J. Q. Anderson, Consultant
Bakersfield, Calif.

THE GREEN RIVER district of northwest Washington State is an area of major interest to many operators. Despite many difficulties, known data justify high promise of significant oil and gas reserves. The large population of the Puget Sound district ensures a ready market for any oil and gas found.

To date, no commercial success has been attained by any oil prospector. However, in recent years, a flurry of leasing and drilling activity was occasioned by the limited production obtained by the Sunshine Mining Company in Grays Harbor County. In the Enumclaw district of Kings County, McCulloch Oil Exploration Company of California, Incorporated, stimulated more than passing interest with three wildcat ventures in 1957 and 1958. These tests had many significant shows of high gravity oil in a large number of thick and permeable massive sand zones.

Geological studies have proven the existence of a number of sedimentary basins. These basins contain large thicknesses of Upper Cretaceous and Tertiary rocks, both marine and nonmarine.

The necessary factors requisite to the origin and entrapment of oil and gas are favorably comparable to known productive areas in California. Lack of persistent wildcatting therefore has limited success in several areas which are geologically promising. By way of comparison, wildcat well density is over 75 times greater

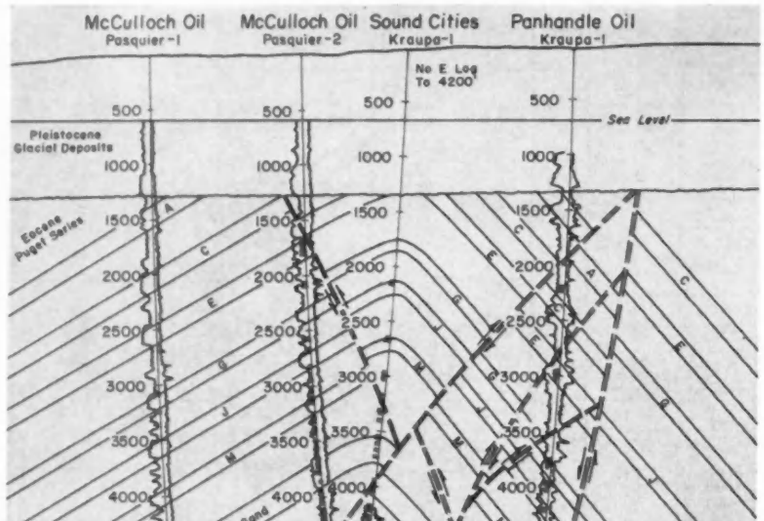


FIGURE 3—Structural cross-section, northern end of Kummer anticline.

in California oil basins than the potential basins in western Washington.

Exploration obstacles. Various methods of geological exploration in western Washington have proven to be quite frustrating. Most of the land surface is covered with a dense growth of vegetation which precludes the accurate delineation of scattered outcrops into a contiguous pattern. Most outcrops are limited to road-cuts, precipitous mountain slopes, and stream drainages. A surface geological map therefore resembles a jig-saw puzzle with most of the pieces missing. Subsurface interpretations from such limited data are obviously quite hazardous, especially in areas where structural and stratigraphic complexities are known to exist.

The presence of Pleistocene glacial debris in many of the lower topographic areas adds to the geologist's frustration. Obviously, all preglacial rock sequences are obscured and the only available outcrops are sought in the beds of streams and rivers which have incised a course beneath the glacial debris.

Many obstacles confront geophysical exploration in such areas. In many instances the drilling of seismic shot holes has been almost impossible, especially in areas of unconsolidated glacial cobbles and boulders. Frequently, the reflections obtained are seldom determinative of true subsurface structural conditions.

Gravimetric and magnetometer surveys occasionally provide subsurface clues. However, the presence of *iron-rich basalt boulders* in the glacial deposits or buried masses of volcanic rocks frequently result in false anomalies.

The foregoing impediments to detailed exploration have inhibited wildcatting in western Washington. Many of the previous tests lacked permeable reservoir rocks although good oil shows in biogenetic source beds often were found to be present. It appears that areas to be considered for future drilling should be limited to those districts wherein the presence of closed structures, permeable reservoir rocks and definite oil shows can be demonstrated.

Green River district promising. Of the several districts which afford high promise in western Washington, the author considers the Green River district to be prospective. This district comprises approximately 600 square miles and is roughly bounded in triangular pattern by the towns of Seattle, Tacoma and Enumclaw (Figure 1). Here again, most of the surface geology is obscured by dense vegetation and glacial deposits. However, all of the surface and subsurface data thus far obtained indicates a favorable potential for oil and gas in this area.

A series of parallel folds occurs on the easterly and westerly flanks of an anticlinorium, the axis of which has a general northward trend from the town of Enumclaw. Outcrops in the bed of the Green River have revealed this series of folds, although such features as length, possible closures, faults, and stratigraphic variations are partially obscured. Surprisingly enough, only one of these folds, known as the Black Diamond or Kummer anticline, has been drilled to date.

A sequence of arkosic quartz-feldspar sands, sandy shales, carbonaceous shales and occasional coal seams known as the Puget Series occurs in the Green River district. These sediments are upper Eocene in age and vary in thickness from 2,000 to over 10,000 feet. Most of these sediments are non-marine in origin but occasional lagoonal or brackish water mollusks have been found in thin interbeds.

In adjacent areas, marine rocks of Oligocene and Miocene age overlie the Puget Series. Such rocks may have been source beds for oil and gas which migrated into reservoir rocks of the Puget Series. Significant shows of oil and gas from the Kummer anticline tests prove the presence of migratory oil into this series. Substantial production from non-marine sediments in several oil fields in California and more recently in Alaska proves that exploration for oil in such sediments can be highly successful.

Area and flowing well. Test wells

drilled on the Kummer anticline have yielded significant information in evaluating the oil and gas potential of the Green River district. In 1915, attention was first drawn to this area by the drilling of a 1,403-foot core hole on the northern plunge of the anticline. This well, known as the Lawson test, was drilled to ascertain the subsurface extension of several coal seams which were then being mined in the adjacent Black Diamond district. At total depth, the well geysered, blowing the tools out of the hole. Following abandonment, the well continued to flow saline water and discharge gas by heads as high as 75 feet or more. Today, after 44 years, gas and water still bubble from this hole.

From 1937 to 1940, drilling operations were carried on in intermittent fashion by the Sound Cities Gas & Oil Company. Their first well, "Bobb 1" (see Figure 2), was drilled to a total depth of 3,440 feet. The hole was cased with 10-inch casing and all promising sand zones were gun perforated in one operation. This resulted in the hole being flooded with water. The operators then placed a packer on the tubing at 3,200 feet and attempted to pump for production from intervals below 3,200 feet. Pumping operations yielded several hundred barrels of salt water per day along with a fair volume of gas. This gas was piped to the company's other test, "Kraupa 1" and was used for fuel to fire the boilers during drilling operations.

After pumping water and gas for over a year, the Bobb well started making considerable free oil. The operators then erected a 600-barrel tank on the property. When completed, the well was flowing oil through the tubing and was making considerable sand. The flow was turned into the tank, and when it was approximately two-thirds full of oil, the well "headed in" with such violence that the tank collapsed. The well abruptly ceased flowing after heading in. Rods, tubing, and packer were pulled and it was discovered that a groove along the side of the packer was filled with a limy mineral deposit. This indicated that the original groove permitted water entry from up the hole into the zone below the packer during the long period of pumping. A complete water shut-off had been finally effected by the gradual deposition of lime scale in the groove. This resulted in the brief production of approximately 500 barrels of oil within a 14-hour period. High pressures had completely clogged the pump with sand thereby accounting for the abrupt cessation of production. The oil was 24 to 26 gravity.

In an attempt to ensure production, the operators then placed a charge of 200 quarts of nitroglycerine in the bottom of the hole. The charge was exploded, the casing collapsed, and all further attempts to clean out to bottom were futile.

The oil zone in the Bobb well consisted of a 20-foot sand bed which was sealed up dip by a large normal fault.

In the period from 1945 to 1957, three other wildcat tests were drilled on the Kummer anticline. All of these wells had interesting shows of oil and gas but no commercial promise. A geological review of the surface outcrops and all sub-surface data by the writer resulted in recommendations for further prospecting. All previous tests were located on the northeast flank of the structure and were presumed to be too low structurally for anticlinal closure.

Recent tests had good shows. In 1957 and 1958, McCulloch Oil Exploration Company of California, Incorporated, drilled three tests on this structure. Core analyses from these wells showed permeabilities ranging from 50 to 3,500 millidarcys and porosities as high as 35 percent. Most of the massive sand zones penetrated had oil and gas shows. These shows were manifested by a bright blue fluorescene of the ditch cuttings under ultra-violet light. Some of the cores had a light tan oil staining and occasionally bled free oil. A total of 16 sand zones were correlated in these wells. The combined thickness of the sands averages 1,800 feet. The oil shows in these sand zones are depicted in the cross section, Figure 3.

Electrical logs of the three wells indicated all sand zones to be wet with salt water. Several drill stem tests confirmed this fact, yielding nothing but a small volume of mud, salt water, and a slight oil scum. Oil samples were too meager for analysis but an approximation of 30 gravity or better would be reasonable.

At the present time, there is no proof that structural closure exists on the Kummer anticline (see Figure 2). All of the wells thus far drilled appear to be located on the north plunge. There is ample evidence that fault traps exist. However, with the exception of the Bobb 1 well, the fault blocks on the north plunge have proven to be barren.

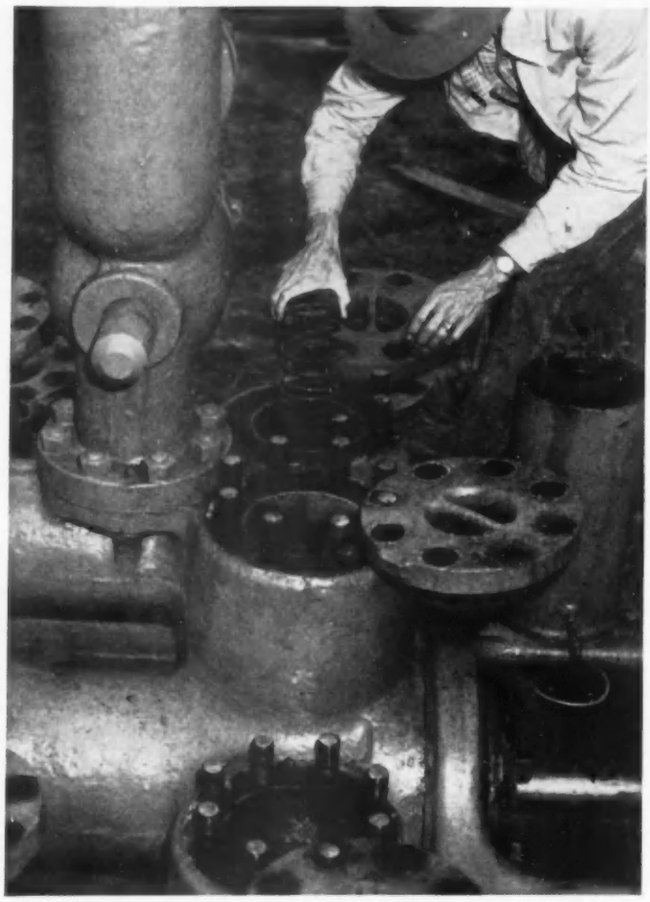
Other structures untested. It should be emphasized again that the Kummer anticline is but one of a series of folds in the Green River district that has been only partially tested to date. Limited data indicates that these folds have lengths of from 6 to 10 miles and average widths of from 2 to 3 miles. The hope for commercial success in any future prospecting in this area is based on the following conclusions:

1. It is likely that millions of barrels of oil have traveled through the many porous sand zones of the Puget Series. Entrapment of portions of this oil in commer-

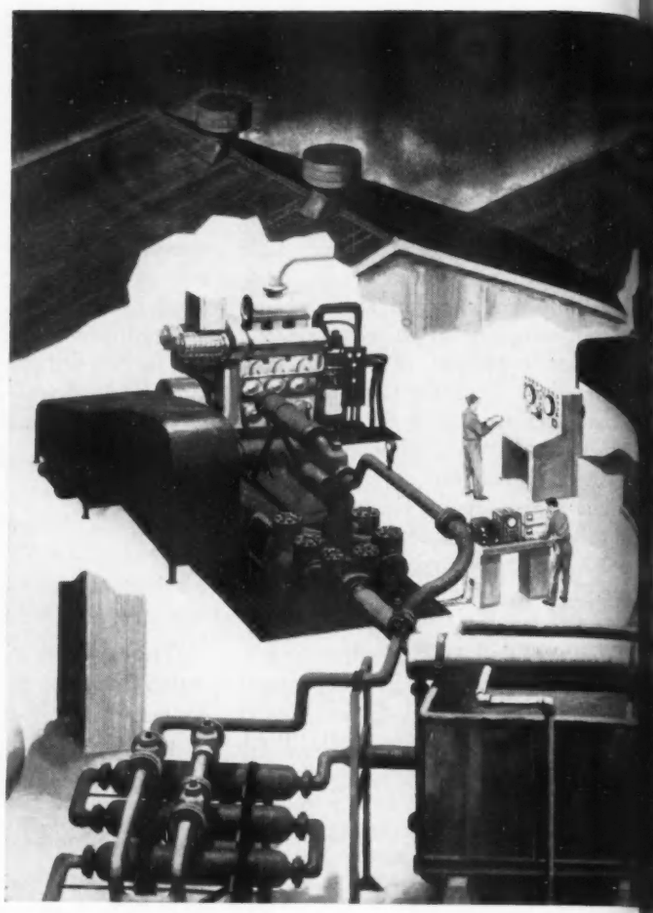
Continued on Page 117

About the Author

J. Q. Anderson has been active as a consulting geologist since 1949. He received his B.A. in geology from the University of Southern California at Los Angeles in 1937 and, following graduate work, joined Union Oil Company of California. He did field geological work in California and the Rocky Mountains for Union, and has since worked in Washington State, among other areas, for other companies. He is also experienced in petroleum enginering work.



IN THE FIELD, the engineer observes various component parts that he has installed as part of the field testing program.



IN THE FIELD TESTING LAB, new products are tested prior to on-location field testing.

PART 11: FIELD TESTING

Know your mud pump— it can save you money

Introduction of new oil field products includes laboratory and on-location field testing programs

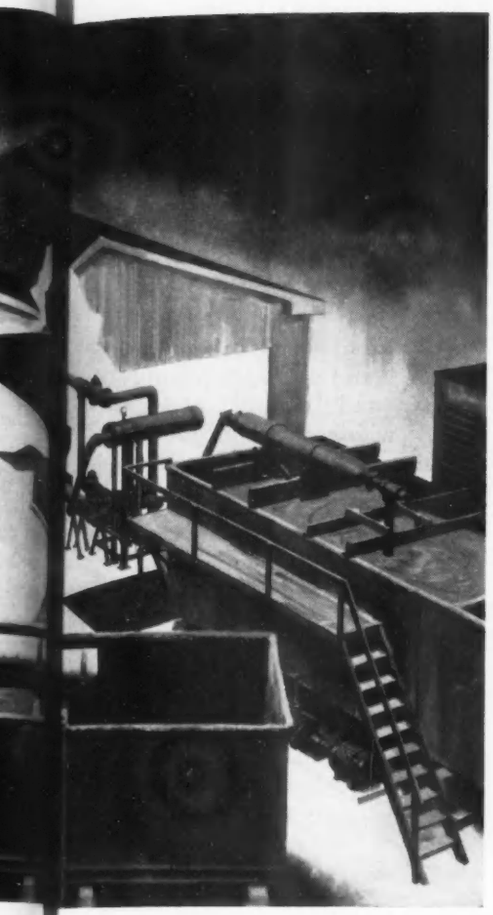
By Clarence Reed
Project Engineer
Mission Manufacturing Co., Houston

THE DEVELOPMENT of a new pump valve design recently introduced to the oil industry required four years of research and field tests, more than 300 separate field installations of 52 different designs, the concentrated efforts of three field engineers, and the help of 33 sales representatives before it could be offered as a marketable product.

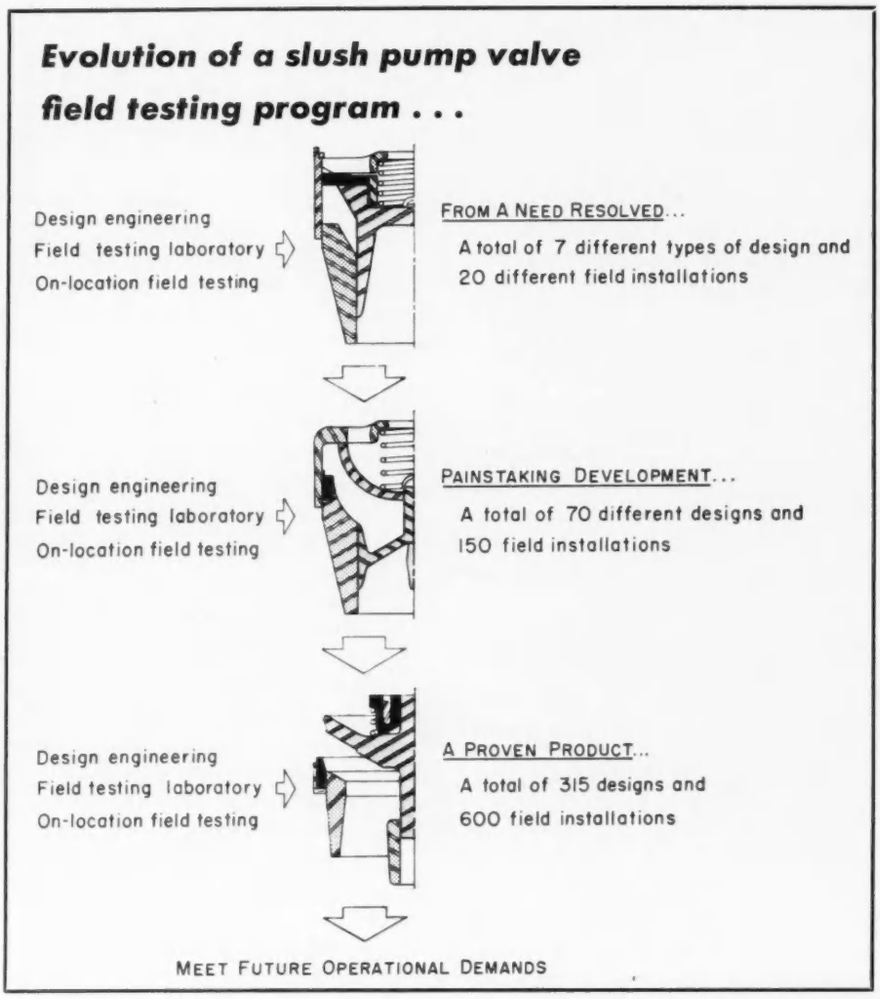
A testing program, if conducted only in the field, is very costly and inconclusive. The cost is usually borne by the rig owner in inconvenience and loss of operational time.

There are three good reasons why proving of products through field tests alone create unnecessary costs for the manufacturer of drilling equipment:

- Invariably a large percentage of inconclusive tests results from the lack of complete 24-hour control of the pump operation.



TYPICAL STEPS (right) necessary during the field testing program to arrive at an acceptable oil field slush pump valve.


Evolution of a slush pump valve field testing program . . .
Design engineering
Field testing laboratory
On-location field testing
FROM A NEED RESOLVED...
A total of 7 different types of design and 20 different field installations
Design engineering
Field testing laboratory
On-location field testing
PAINSTAKING DEVELOPMENT...
A total of 70 different designs and 150 field installations
Design engineering
Field testing laboratory
On-location field testing
A PROVEN PRODUCT...
A total of 315 designs and 600 field installations
MEET FUTURE OPERATIONAL DEMANDS

- Chances are increased that the test equipment will be lost or misplaced.
- Because the experimental installation must be subjected to the requirements of the drilling program, and test conditions are not always the best even on rigs operated by the most cooperative companies.

Realizing the importance of holding the cost of their products down and obtaining more accurate field information, some manufacturers of drilling equipment are conducting rigid "field" tests of their products in the laboratory before testing them in the field. As a result, the prototype products are being tested under closely controlled laboratory conditions, and more conclusive evaluations are being obtained.

The field testing program includes two-phases laboratory field testing and on-location field testing.

Laboratory field testing. This program is primarily for elimination purposes and is conducted in the laboratory pumps under conditions made purposely severe so that fluid end parts failures will be accelerated. The first pump installation has now been increased to three pumps and it has been found that every dollar invested in this controlled testing will return as much usable data as will the actual rig installation. Sharp sand is added to the drilling mud and changed from time to time as it is worn smooth.

The pumps are usually run at maximum pressures and, sometimes, badly worn mating parts are even provided such as oversize liners when piston tests are in progress. Approximately 3 out of 4 designs can thus be eliminated before the project is sent to the drilling rig.

On-location field testing. The acid test of a new design should be conducted on actual drilling rigs, by several resident engineers in widely separated areas at the same time.

Because most drilling men are vitally interested in improvements in their equipment, the field test engineer generally has all the cooperation he requires from the drilling crew. Normally, he is conducting tests using material which has been designed and prepared at the main plant, in an effort to solve some particular problem in his area. Usually, these designs are the direct result of a drilling man's long association with a specific problem.

Such cooperation between field men and the test engineer, resulted in the development of a piston rod with tool

joint crosshead threads, for faster installation in the pump, which is now covered by an API standard and is specified as original equipment for many pumps.

Another example is a tool for removing the piston from the rod which evolved from the long standing oil field practice of holding the piston rod vertically and dropping a heavy sub over the rod from the crosshead end to strike the piston and remove it. Other designs, which may be adopted from new processes or materials from other industries, are sent to the field test engineer by the company's design engineers along with complete description covering the purpose of the test, the type installation required, and an approximate date deadline for his summary of conclusion.

From the large number of rigs the test engineer has available, he can then select the location which provides the conditions required.

Why over-all field testing is needed. This type of field testing is being accepted by an increasing number of manufacturers. No matter how carefully field conditions are duplicated at the plant, there are some factors critical to fluid end parts operation which cannot be reproduced under laboratory conditions. It also would be impractical to attempt to duplicate all of the vastly different conditions which are more or less peculiar to particular areas.

In Louisiana, higher pump pressures are required with greater drilling depths. In some Mid-Continent fields, smaller mud pumps may be used but clear water is pumped with resulting low cushioning effect on the valves; this results in large shock loads and more rapid failures.

Water drilling with higher speeds in this, and other areas, will account for increased wear on pump rods, liners, and other moving fluid end parts. In the hard rock country of the Rocky Mountain area and the gravel beds of the Texas Gulf Coast, the drilling fluid carries rock particles which may damage the valve sealing member.

In Southwest Texas, even moderately deep wells have encountered exteremely high bottom hole temperatures resulting in rapid failure of some of the best synthetic rubber parts. In the Permian Basin and areas of Lake Maracaibo, failure of metal pump parts is a real problem because of corroding properties of formation fluids encountered in one case and the high oxygen content of the water used for making the drilling mud in the other.

In almost all areas the operator may require high pump pressures or may drill through formations requiring lost circulation material. In drilling the surface in a specific hole, water at high speed and low pressures may be circulated. However, with an increase in depth a few days later, a heavy oil base mud may be used at high pressures and temperatures. The same fluid end parts may be called on to withstand all of these conditions, so they must be proof-tested as widely as possible.

Materials and designs are available, and have been field proven to handle most of these individual problems. However, many were eliminated from consideration when the rig was moved a few miles and vastly different conditions were encountered.

Stainless steel pump liners proved an economic advantage in solving the West Texas and the Venezuelan corrosion problems, and a special tough synthetic material took care of the gravel in rock cutting problems in the case of the valve sealing member. These parts offered economic operation under certain problem conditions. Even though the material was more costly, a widespread field test program proved that they would work satisfactorily when most other conditions were encountered.

The design also must be such that installation can be accomplished by inexperienced "hands" as well as those with long rig service. This can only be determined in the field. For example, a particular rod gland packing design gave superior results at a plant installation, but failed in short order in several field tests because its many parts did not allow foolproof installations.

Standard parts comparison is necessary. The test representative always prefers to install new "standard" material on one side of the pump so that a direct comparison can be made with the experimental design.

"Why use any of the regular material—I know it won't do the job," is often the voiced objection to this procedure; but *new* regular control material might perform adequately during the test, or conditions may change enough to allow misleading (though excellent) service life from the experimental parts, if new "standard" parts are not used for direct comparison. During an installation of this nature all mating parts should be in good serviceable condition.

If a piston test is being run, the liners on both sides of the pump (with both test and "control" equipment) must be within a few thousandths of the same size and must have the same smooth inside surface.

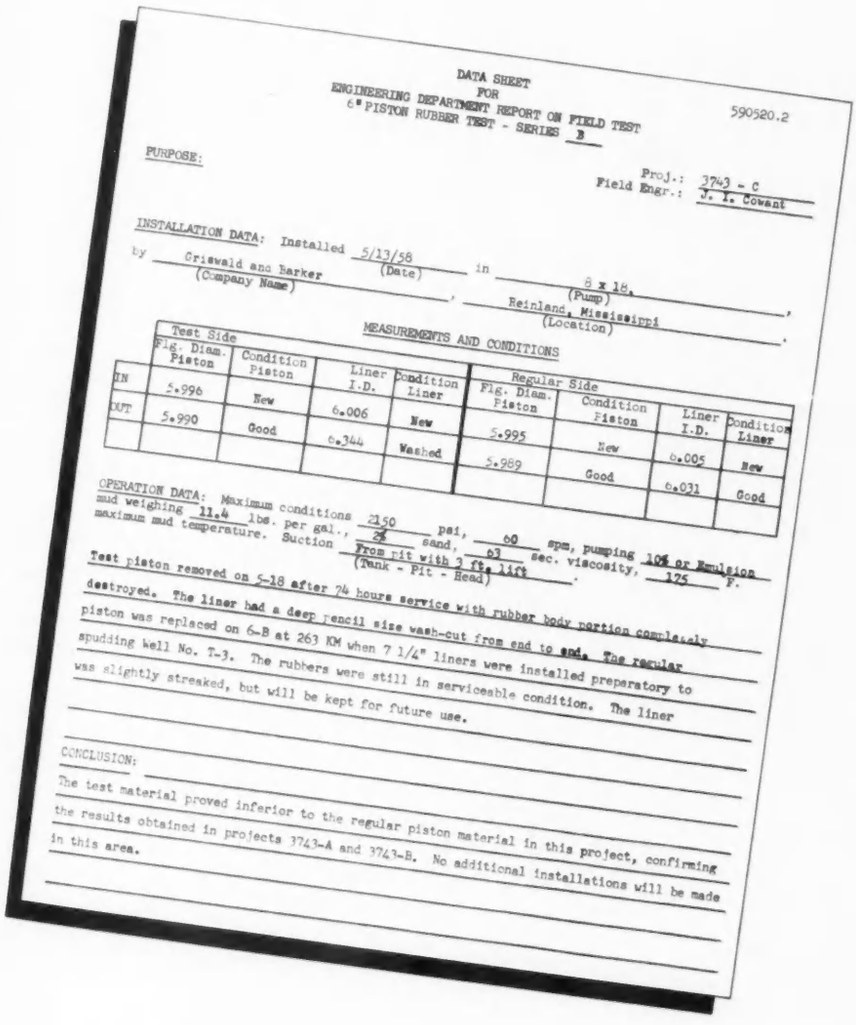
If a test of a pump valve is being installed, the upper valve stem guides must be in good condition. The installation may be made at a time when the pump is to be down for several hours, making round trips, waiting on cement, or moving the rig. However, they are usually made in the middle of the night and with no assistance from the crew members as they may be needed more urgently for other jobs. Such periods of inactivity will also be used to inspect the material during the progress of the test.

The proper conduct of a field test is a hard job. The field test representative may have 50 or more test installations running at the same time on widely scattered rigs so every effort must be made to keep up with all changes in key rig personnel, familiarizing all with the test material being run. Their cooperation in saving all parts that are removed and recording all pertinent data in the drilling report is vitally important for good results.

On some test projects, where accurate control is necessary, the engineer will remain on the rig for several days at a time to insure that he is present when anything occurs which is considered important to the proper conclusion on the project.

One of the test engineer's biggest problems is the recovery of all the changed material while conducting a test. The examination of a part which failed rapidly can provide essential information. Sometimes very accurate records are maintained and the engineer has all the pertinent data available but conclusion cannot be drawn because the test part was removed and lost.

On some rigs, where the test engi-



DATA SHEET
FOR
ENGINEERING DEPARTMENT REPORT ON FIELD TEST
6" PISTON RUBBER TEST - SERIES B

590520.2

PURPOSE:

Proj.: 3743 - C
Field Engr.: J. L. Cowart

INSTALLATION DATA: Installed 5/13/58 (Date) in 8 x 18, (Pump)
by Griswald and Barker (Company Name), Reinland, Mississippi (Location).

MEASUREMENTS AND CONDITIONS

	Test Side				Regular Side			
	Fig. Diam. Piston	Condition Piston	Liner I.D.	Condition Liner	Fig. Diam. Piston	Condition Piston	Liner I.D.	Condition Liner
IN	5.996	New	6.006	New	5.995	New	6.005	New
OUT	5.990	Good	6.344	Washed	5.989	Good	6.031	Good

OPERATION DATA: Maximum conditions 2150 psi, 60 spm, pumping 10% or Emulsion mud weighing 11.4 lbs. per gal., 2% sand, 63 sec. viscosity, 175 F. maximum mud temperature. Suction From pit with 3 ft. lift (Tank - Pit - Head).

Test piston removed on 5-18 after 74 hours service with rubber body portion completely destroyed. The liner had a deep pencil size wash-cut from end to end. The regular piston was replaced on 6-B at 263 KM when 7 1/4" liners were installed preparatory to spudding well No. T-3. The rubbers were still in serviceable condition. The liner was slightly streaked, but will be kept for future use.

CONCLUSION:

The test material proved inferior to the regular piston material in this project, confirming the results obtained in projects 3743-A and 3743-B. No additional installations will be made in this area.

Field testing data must be recorded accurately. Here is a typical field data sheet that is used for recording information of new products or new designs that are being field tested.

neer is not thoroughly familiar with all the members of the crew, extra precautions are necessary to guard against loss of material. Sometimes special containers are provided for the test materials. Also, the crew members are encouraged to mark and place all parts in a specific location, or the test engineer may mark the pump so he can determine if the particular pot cover or liner cover has been removed since his last visit.

The test engineer must have access to all daily reports and other rig records. Otherwise, he may overlook some factor which is vitally important in reaching the proper conclusion as to the value of the experimental installation. The information is held in the strictest confidence, only as much being used in the field report as has direct bearing on a conclusion.

The field testing engineers are usually familiar with designs and the past research history of a specific product prior to undertaking a field testing program.

One manufacturer's field test program has included more than 3,600 separate designs and changes which have been conducted over a period of 20 years in more than 20,000 separate installations. More than 95 percent of these test projects were eventually discarded as unsatisfactory. However, extremely valuable information was obtained for future design work in the continuing program to provide more economical products in the face of more severe drilling conditions.

TO BE CONTINUED

Puget Sound Prospects

Continued from Page 113

cial quantities is yet to be proven.

2. The sand zones of the Puget Series have varying permeabilities and porosities, most of which are sufficient to contain vast quantities of oil and gas.
3. Marine sediments are present in some areas of the Green River district and it is presumed that they generated some of the oil which has migrated into the Puget Series. It is probable that many of the structures west of the Kummer anticline also have substantial interfingerings of marine sediments.
4. The orogenic events in the structural history of the Green River district were of sufficient magnitude to assure a high degree of folding and faulting. Such events would favor the probability of anticlinal closure on several of the structures in this area.

Core hole drilling needed. Although the foregoing conclusions suggest a favorable potential for commercial oil and gas in the Green River district, many problems remain to be solved by the wildcatter. The obstacles to detailed exploration, as listed previously, would entail the expenditure of considerable capital. The most desirable objective would be to obtain good evidence of anticlinal closure before drilling to any great depth. This could be accomplished best with a vigorous core drill program.

There are several areas in the Green River district where the thickness of the Pleistocene and Recent deposits is less than 500 feet. A core hole program in such areas to depths of 1,000 to 1,500 feet would certainly provide key answers for future wildcatting.

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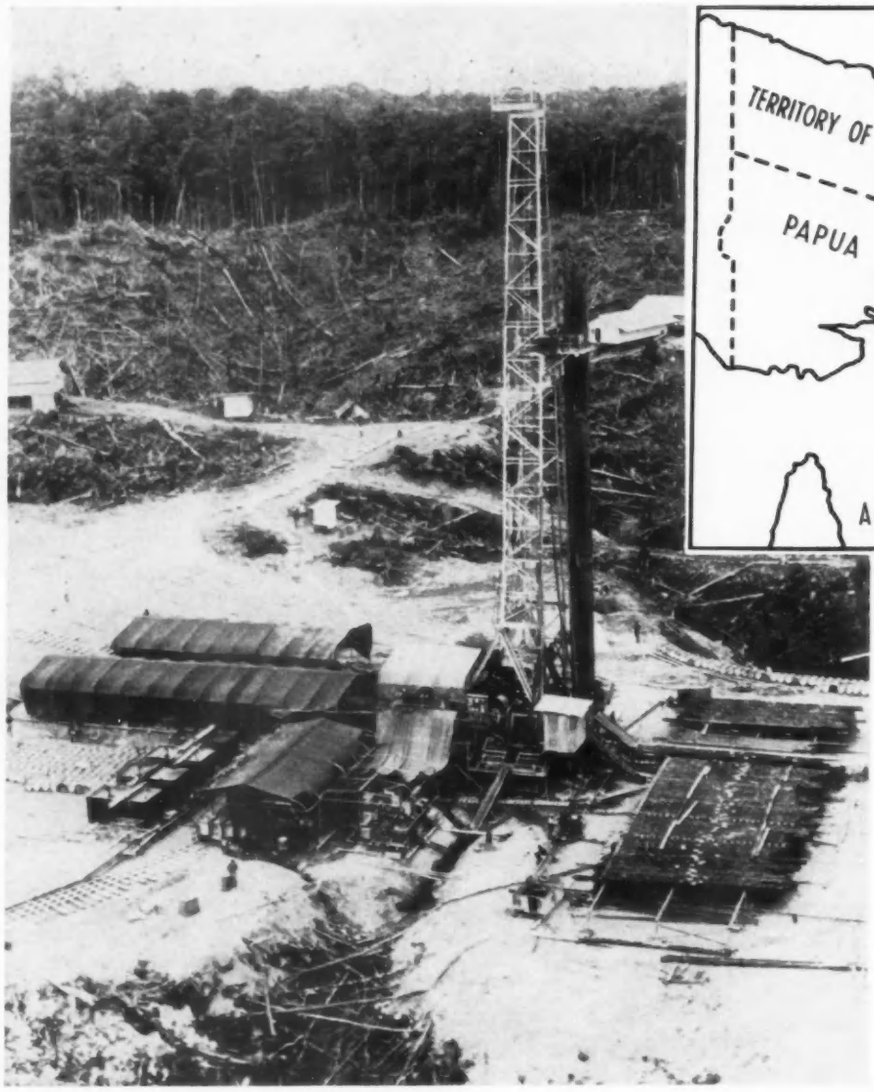


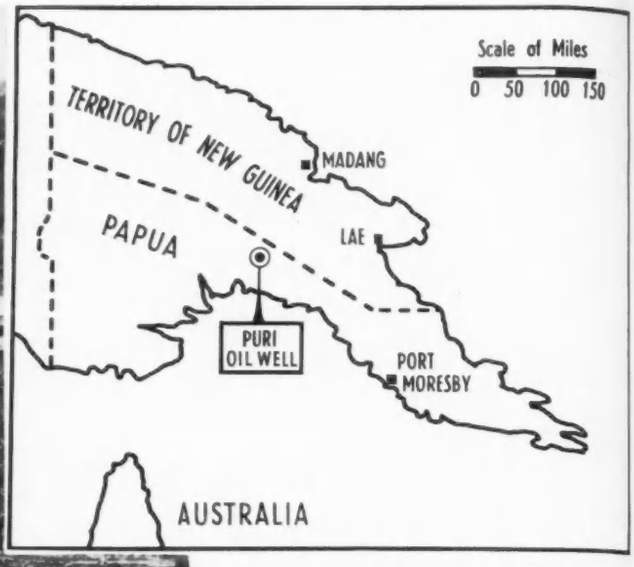


FIGURE 1—An oil well at Puri, in the Australian territory of Papua in late 1958 produced about 3,500 barrels of crude oil. But it went to salt water. Plans then called for drilling deviated holes by setting whipstocks in the original hole.

FIGURE 2—The drilling rig of the Papua discovery well, Puri 1. The well site is situated in rugged, inhospitable country. If the discovery has commercial value, a pipe line will be needed to carry the oil from the area.

Non-commercial discovery may forecast oil in Papua

Australian territory well yields 3,500 barrels of oil from limestone at 7,460-7,508 feet

SOME OIL has been discovered, although so far not in commercial quantity, in Australia's territory of Papua. About 3,500 barrels of oil was recovered last November in the test well, Puri 1, by Australian Petroleum Company, Pty. Ltd. But salt water intruded, and production declined rapidly.

To appraise the structure on which the oil was found, two holes deviated from the original Puri well were to be drilled, and geological and geophysical surveys of the area were planned.

Meanwhile, helicopter access to the Bwata structure, some 15 miles to the northwest of Puri, has been gained, and a site has been prepared for drilling a hole to test the limestone horizons which yielded the oil at Puri.

The Puri discovery is about 250 miles northwest of Port Moresby and about 300 miles northeast of the northern tip of Queensland, being across the Coral Sea from continental Australia. The well was the first of about 19 wildcats drilled in Papua to indicate oil production.

Drilling at Puri was carried out by Australasian Petroleum Company Pty. Ltd., as operator for a partnership of three companies: British Petroleum (45%), Socony Mobil (45%), and Oil Search Ltd., an Australian company, (10%).

After a week of fairly substantial oil flow in late 1958, water was coming out with the oil. Further test wells were projected in order to determine the commercial possibilities of the discovery.

In Puri 1 a limestone zone between 7,460 and 7,508 feet flowed at the rate of 1,000 barrels of crude oil daily, with considerable gas, on brief test, with increasing amounts of water.

Oil possibilities in Papua have been recognized since discovery of oil and gas seeps in 1911 near the Vailala River. Sedimentary basins exist west of Port Moresby and extend beyond the Dutch New Guinea border.

Australasian Petroleum during the past 20 years has carried out a comprehensive oil search throughout the sedimentary basins. It has used aerial photography, geological and geophys-

ical surveys, stratigraphic drilling, and deep well drilling.

The basins are located in the foothills of the central mountain chains of Papua and New Guinea, in the delta and low lying terrain nearer the coast, and in the western sunklands of the Fly, Ramu, and Turamu rivers.

The region is covered with a thick, virtually impenetrable mat of vegetation. There are dense, tropical rain forests in the higher terrain, Nipa palm in the deltas, and sago palm in the swamps. Rainfall exceeds 100 inches per year and goes over 300 inches in some places, such as the Kikori area.

Australasian Petroleum has largely eliminated the need for roads to drilling sites. Instead, it charters helicopters, capable of carrying two ton loads, and breaks drilling outfits down into loads not exceeding two tons. Puri 1 was one of four wildcats drilled without road building, although the sites ranged from 9 to 15 miles from navigable rivers.

FIGURE 3—Base camp of the Australasian Petroleum Company at Era, on a bend of the Era River, Papua. Photograph shows helicopter hangar and stores and machine shop. The helicopter is being prepared here for a flight to the drill site where oil flowed, about 12 miles distant across inhospitable, rugged country. The heavy boardwalk shown in the picture is needed to prevent machines and load from sinking into the soft, wet ground.

In the "helirig" operation, a base camp is built on the bank of the nearest navigable river, as close as possible to the drilling location. The camp accommodates drilling and helicopter crews and native workers, and serves as a base store and workshop.

A land party clears the drill site for a helicopter to land. A tractor, broken down into components, is flown in and assembled to complete clearing and excavate a rig site. Then follows building material for huts for the drilling crew and for rig site buildings. Finally, components of the drilling outfit and sufficient consumable goods are brought in to permit drilling to begin. Working in shifts, the crews are flown between base camp and rig site during the course of drilling, and supplies of consumables are maintained. On completion of drilling, the outfit and all salvable material are flown out.

FIGURE 4—Here on location in Papua is a helicopter capable of carrying 12 persons or a load of 4,000 pounds. Two of these flying machines carried in an entire drilling rig, its equipment, and buildings to the drill site. The loads were carried a distance of 12 miles across trackless jungle. In the 'copter, a trip takes only about 9 to 12 minutes, depending on the load carried.

The majority of helicopter loads are carried externally. They are suspended by a cargo net or sling from a hook attached to the undercarriage. Loads are assembled on a cargo bay before being flown. But the helicopter need not land, as the loads are attached to the hook by one of the ground crew members, while the helicopter hovers, and are unloaded at destination by using a releasing device controlled by the pilot from the cockpit.

Time saving is the main advantage of a helicopter service of drilling operations. But the economic saving is considerable where a difficult road access of more than five or six miles can be eliminated.

ACKNOWLEDGMENT

Information on oil development in Papua and photographs furnished by the Australian News & Information Bureau.

Why the oil industry needs a depletion provision

Drilling costs mount as wells go deeper and operational expenses increase

IT TAKES big money, plus a gambler's nerve to survive in the oil industry—and sometimes that isn't enough. If oil men are to continue to invest billions in the tremendously risky business of building this nation's oil and gas reserves, the 27.5 percent depletion provision is a prime necessity.

Proof of these two statements is dramatically presented in the following statistics:

- Each day during a two-year period (1955-56), oil men and oil companies drilled an average of 155 wells—at a cost of $7,490,000.
- Each day during the same period, an average of $2,306,000, or 36.4 percent of the investment, went down the drain for 58 nonproductive dry holes.
- The average cost per well went up from $46,000 in 1955 to $50,200 in 1956.
- Average cost per foot drilled increased 11.9 percent in the three-year period, 1954-56. In 1954, the average cost per foot was $11.03 (U.S. Bureau of Mines Census); in 1955, $11.55; in 1956, $12.35.

The increased costs during these years were due mainly to increased offshore activity, deeper drilling, plus higher labor and materials costs. These same cost factors have continued to increase to the extent that current drilling costs per foot will undoubtedly average more than the 1955-56 period. For example, average hourly wages in production and drilling were 8.5 percent above the 1956 average. In 1958, average J-55 casing prices were 15.7 percent above the 1956 average.

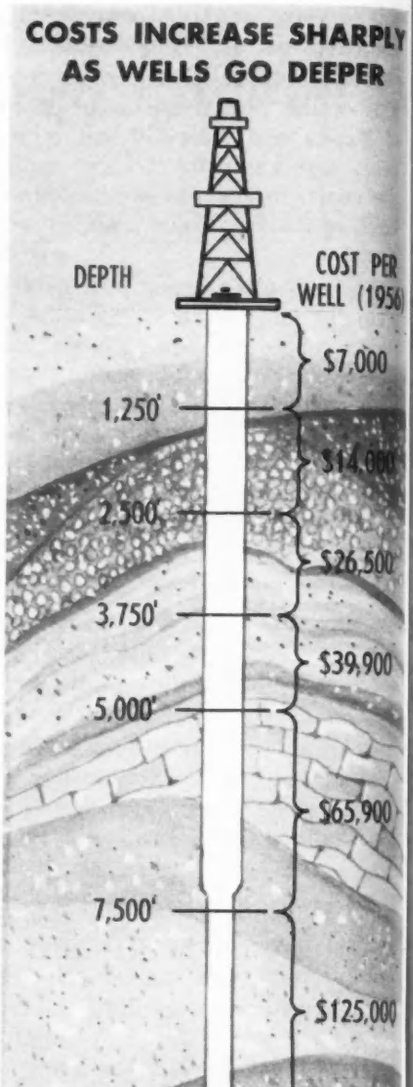
Joint Survey. The above statistics are the result of a joint survey conducted by the American Petroleum Institute, the Independent Petroleum Association of America and the Mid-Continent Oil and Gas Association to provide authoritative information on the cost of drilling and equipping oil and gas wells and dry holes in the U.S. The first such study was published in 1955, based on 1953 data.

The associations conducting the survey emphasize that the expenditures reported include only the actual costs of drilling and equipping the wells through the christmas tree at the well head, without any allocation for administrative overhead, production equipment and pre-drilling expenditures.

The study also shows how costs skyrocket as the depth of wells increases. For example, in 1956, the average cost of 14,006 wells ranging in depth from 2,501 feet to 3,750 feet was about $26,500, while the average cost of the 150 wells over 15,000 feet (averaging 5¼ times as deep) was $761,700, or nearly 29 times as expensive.

Also significant is the high cost of drilling wells in offshore areas. For example, the average cost per offshore well in 1956 was $415,000, compared with an average cost of $50,200 for wells drilled in other areas.

It is also costing the oil industry more to find nothing. Compared with the 1954 Bureau of Mines Census average of $34,500 each, the cost per dry hole rose to $37,300 in 1955 and to $41,600 in 1956. This represented a 20.6 percent increase in dry hole cost between 1954 and 1956.



The average cost per foot of dry holes, including both dry development and dry wildcat wells in 1956 was $10.26, up from $9.21 in 1955 and $8.06 in 1954. —The End

A marsh buggy crosses a canal in southern Iraq. It is being used in seismic surveying for Basrah Petroleum Company.

The floating headquarters of a seismic party operating in the marshes of southern Iraq. The geophysical work is being carried out by Basrah Petroleum Company.

Geophysical parties work in marshes of South Iraq

Air boats, marsh buggies, house boats, barges and floating rafts are among facilities employed

BASRAH PETROLEUM COMPANY has been carrying on extensive geophysical work in the marshes of southern Iraq. The geophysical parties have operated mostly in areas like the silt and alluvium covered expanses between the Tigris and Euphrates rivers. Seismic work proved its effectiveness in the region in the past by leading to discovery of the oil fields at Zubair and Rumaila in southern Iraq, near the Kuwait border and the Persion Gulf.

In the current geophysical campaign, various types of waterborne and amphibious craft are used. They include air boats, marsh buggies, house boats, barges and floating rafts.

The air boat, a sleek flat bottomed craft, has a 190 hp aircraft engine and propeller. It can travel at high speed in water a few inches deep. It carries personnel and stores between the party's land camp and operational locations.

The seven ton marsh buggies, with huge wheels that also act as paddles, have 150 hp engines. They can travel 12 miles per hour on land and 6 mph on water. They carry 15 to 20 men over the marshes, which are normally 4 to 10 feet deep.

Exploration in the marshes was started in late 1957. It began from Halfiyah, a hamlet 45 minutes east of Amara by road. By the spring of 1958 operations were in progress in the Hor Al-Hawizeh, a swamp adjoining the Iranian frontier. The exploration crews transferred their houseboats from the middle of a lake to a location in the marshes. The boats were tied up against an irrigation bund between two rice fields. The party's land camp was situated at the edge of the marshes. From there, rations and equipment were sent to the party by air boat and motor launch. The camp also served as a maintenance depot for repair and servicing of operating equipment. The next part of the journey was by fast air boat.

The floating camp consisted of a dozen 20 foot long fibre glass house boats, with hardwood and plywood upper structures. It accommodated eight Britishers, one Dutchman and 28 Iraqis. Most of these boats had sleeping accommodations. One was fitted out as a hot and cold shower bath, and another as a kitchen, with an electric cooker and refrigerator. Electric power came from two 45 kw generators in a separate barge.

This floating camp had its own drinking water supply. Water was pumped from the marshes on to a special barge, then filtered and chlorinated in 200 gallon tanks. The house boat camp was designed by Basrah Petroleum Company engineers. It was built under contract by a local firm of contractors. It is towed from place to place by motor launches.

Notwithstanding the conveniences of the camp, life in it is neither easy nor luxurious. The living conditions are cramped. The summer season is hot and sultry, and the winter months are cold and damp. There are also swarms of flies, mosquitoes, midges and other insects to contend with, not to mention water rats, snakes and wild boar. —**The End**

Fluid loss controlled by . . .

Acrylic polymers as drilling mud additives

Vinyl polymers show less decomposition than starches or cellulose derivatives

By C. S. Scanley, Group Leader
Refinery Chemical Section
Industrial Chemicals Research Dept.
American Cyanamid Co.
Stamford, Conn.

ACRYLIC POLYMERS have been used as fluid loss control agents in drilling muds for about eight years. However, little published information is available on the subject. This article will discuss:

- A general background on the polymers themselves with attention being given to the history of their development
- Their chemical nature and preparation
- Polymer properties
- Their mode of interaction with clay
- The specific effect of polymer variables on drilling mud properties

History of development. In the early stages of the development of synthetic water-soluble polymers, it was discovered that these materials could affect the fluid loss properties of mud in much the same way that starch did. It also was known that synthetic water-soluble polymers might act as either dispersants or flocculants for clay systems, depending upon the polymer type and the conditions of use. Starch and cellulose derivatives generally were known to be subject to decomposition of a hydrolytic or bacterial nature and it therefore appeared desirable to develop vinyl polymers as drilling mud additives.

Vinyl polymers would be expected to be non-fermenting and to have high temperature stability because a vinyl polymer backbone is composed of carbon to carbon linkages that are stable to hydrolysis and bacterial attack. One vinyl type, an acrylamide-sodium acrylate copolymer is illustrated in Figure 1. Starch and cellulose derivatives on the other hand (Figure 2) are composed of sugar molecules attached to each other by what is known as a glycoside linkage that is susceptible to enzymatic or hydrolytic attack to give the individual sugar molecule and cleavage of the polymer.

The actual use of acrylic polymers began about 1949. All of the early products were characterized by stability to bacterial attack and resistance to high temperature decomposition. As a class, however, they were extremely sensitive to contamination and caused high viscosity and gel strength in many systems.

Monomer and polymer synthesis. The principal chemicals involved in the preparation of acrylic polymers (Figure 3) are acrylonitrile, acrylamide and acrylic acid. Acrylonitrile is prepared by the addition of hydrogen cyanide to acetylene in the presence of cuprous chloride and cyanide, and ammonium chloride catalysts in an aqueous system. The resulting acrylonitrile is the single most important chemical in the further steps of making acrylic polymers. Acrylonitrile may be hydrolyzed in the presence of acid to give either acrylamide or acrylic acid. Several other routes to acrylic acid are also available and use one of the following as starting

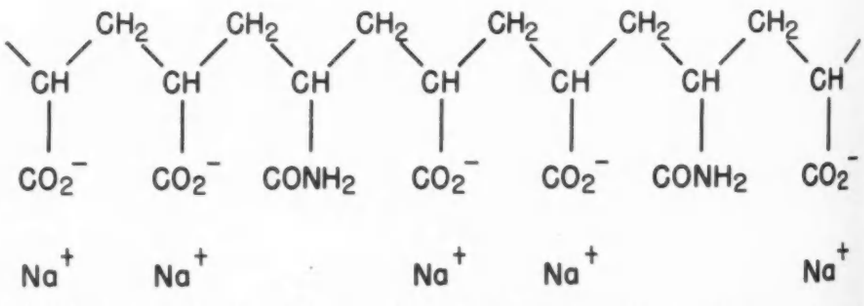
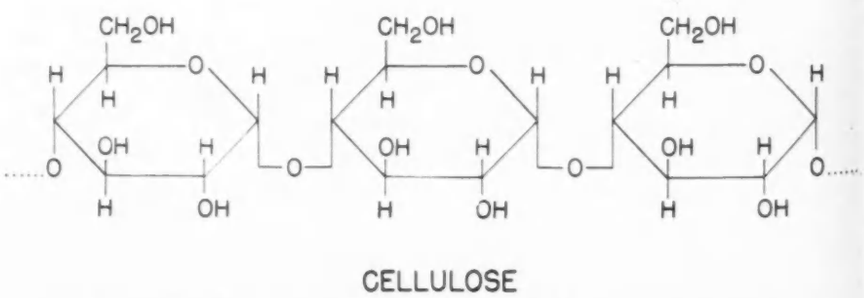


FIGURE 1—Here is a chemical composition of an acrylamide-sodium acrylate copolymer.



CELLULOSE

FIGURE 2—The cleavage of the polymer is at oxygen links between rings.

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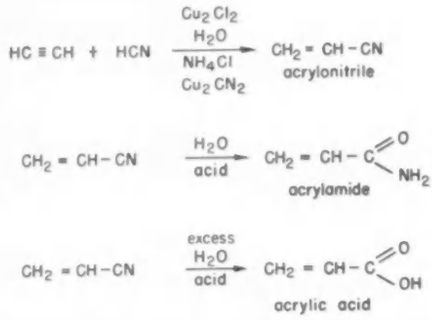

FIGURE 3—Here are the principal chemical syntheses of acrylic monomers.

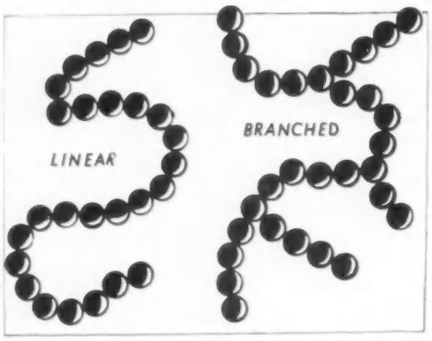

FIGURE 5—Polymer structural chains may be either linear or branched.

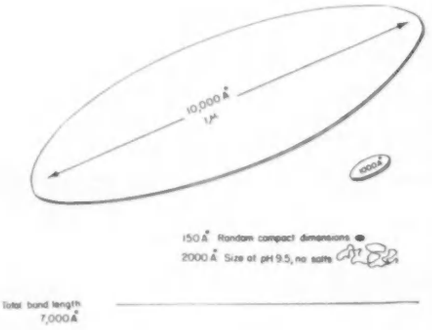

FIGURE 6—Here is a comparison of clay and polymer particle sizes.

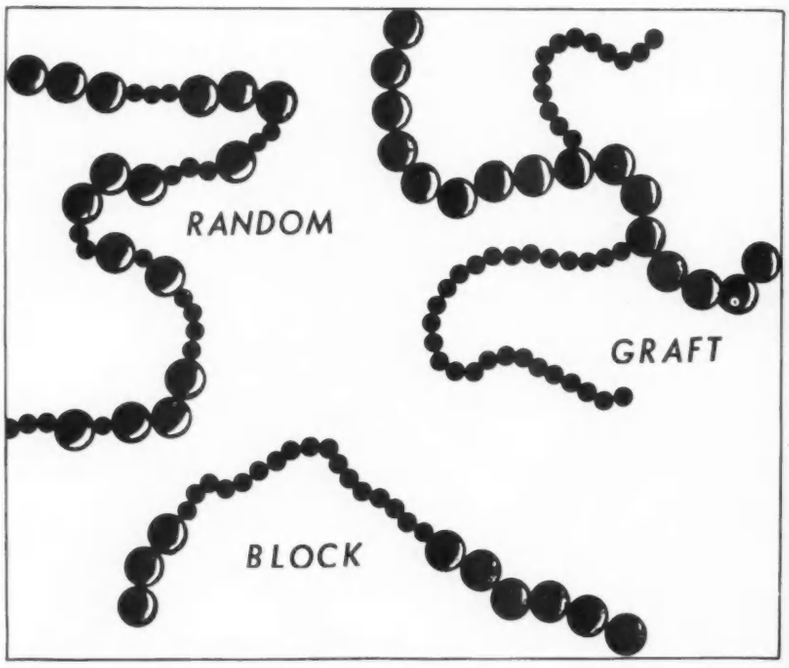

FIGURE 4—Here are several different types of copolymer.

materials: ethylene cyanhydrin, β-propiolactone, acrolien, or carbon monoxide and acetylene.

Chemically, there are several methods that might be used to make polyelectrolytes from these monomers.

- Polymerize acrylonitrile and treat the polymer with aqueous caustic to produce a polymer containing amide and sodium carboxylate groups on the vinyl polymer backbone.
- Polymerize acrylamide and hydrolyze in aqueous caustic to a polymer also containing carboxylate and amide groups.
- Polymerize acrylic acid and neutralize it, with the resulting polymer being a pure sodium polyacrylate.
- Make a copolymer from a mixture or acrylic acid and acrylamide.

With any of these systems, it is also possible to include other vinyl monomers to give polymers that have modified properties. Probably most of the above methods are represented in the various acrylic products on the market today where they may find use as thickeners, adhesives, flocculants, soil conditioners, etc.

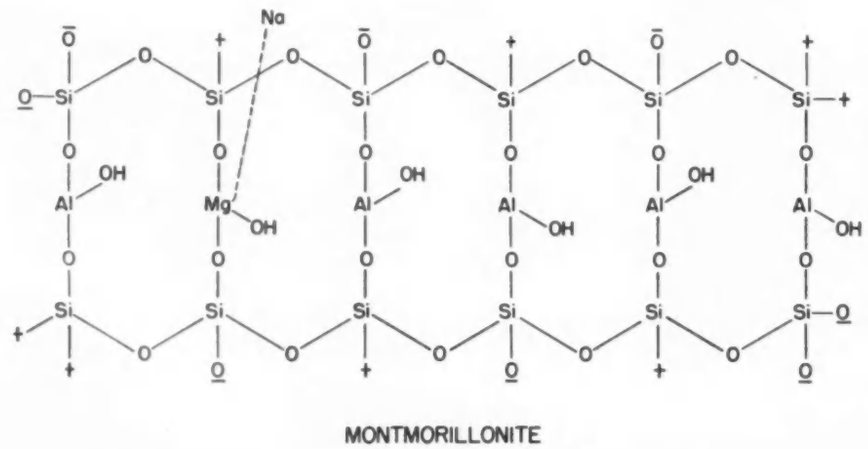

FIGURE 7—Montmorillonite is made up of layers of silicon, aluminum, and oxygen.

Structural factors. In a vinyl polymer containing acid and amide groups (Figure 1), two characteristics might easily be varied, molecular weight and the acid-to-amide ratio. These will be discussed in detail later. There also are other variations possible; although some at the present stage of the art are practical only in the laboratory. They should be included in order to give an idea of what is developing in polymer chemistry. These other structural variations exist because of the possibility of combining two monomers in several different ways as illustrated in Figure 4.

First is a random copolymer in which the groups are distributed along a chain in random order. This is the conventional type of commercial copolymer. In a graft copolymer, the backbone of the polymer is composed entirely of one type of monomer, while branches off the sides are of another type. In a block copolymer structure, all the units of a given kind are grouped together in repeat-

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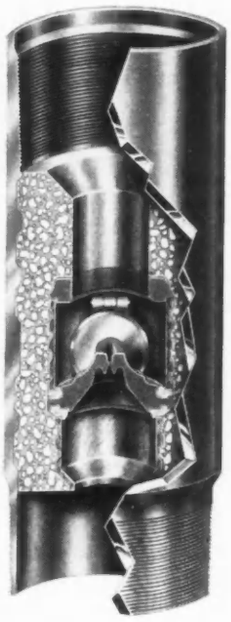

Filrite Float Collar
Fig. 451

FILRITE EQUIPMENT was designed to allow automatic filling of the casing while it is being run and to eliminate pressure surges which might break down weaker formations.

CEMENTROL EQUIPMENT was originated by Larkin for the purpose of protecting exposed producing formations against contamination by cement. Cementrol effectiveness has been proved in thousands upon thousands of wells over a period of fifteen years.

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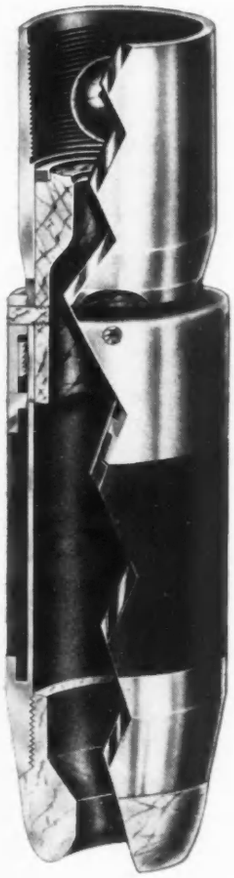
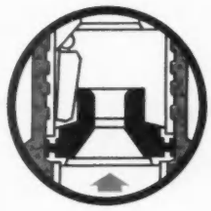
Filrite Equipment contains a resilient diaphragm valve which prevents entrance of well fluid into the casing until several joints have been run. When fluid pressure from below overcomes the inherent resistance of the valve to open, the valve then opens and allows partial fill of the casing without overflow. This type of fill-up is continuous until casing is landed.

The Cementrol Guide Shoe serves as a guide until casing is landed. A bridging ball is then dropped and by pump pressure from the surface the Cementrol packing element is expanded against the wall of the hole and no cement can contact the producing zone.

For additional details on Filrite and Cementrol please refer to your Larkin catalog—or call your nearby Larkin representative.



Cementrol Guide Shoe
Fig. 227

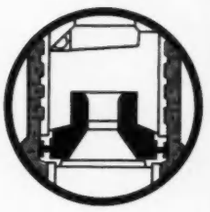


A

Circle A, a view 90° from that of the large illustration, shows the Filrite valve in running-in position. The resilient diaphragm valve remains closed until the differential fluid pressure across it overcomes its inherent resistance to open.

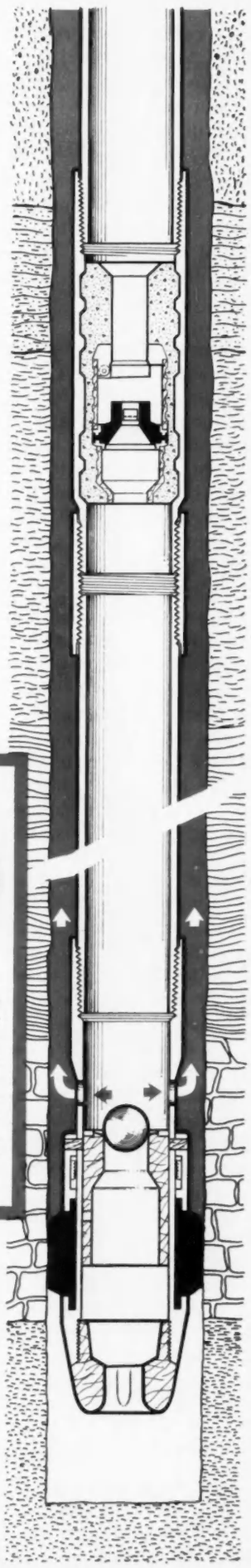
B

Circle B shows the rubber diaphragm inverted by pump pressure as the well is being cemented. Filrite is full opening and will allow passage of a bridging ball to actuate other equipment which might be installed on the casing beneath a Filrite Collar.



C

Circle C shows the spring-loaded flapper valve in closed position after being released by inversion of the diaphragm. The flapper valve in the Larkin Filrite equipment is very strong and has no depth limitations.



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ing sections. Polymers of each of these types having identical molecular weights and containing equal numbers of each type of functional group, have different physical properties.

There is another gross structural variation possible and this is concerned with whether the polymer chains are linear or branches as illustrated in Figure 5. This variation is possible within each of the previous types.

Polymer clay interaction. For clarification of polymer-clay interaction it might be well to begin with the general dimensions of clay and polymer particles. Clay particles are known to consist of thin plates of the order of 50 Angstroms thick but anywhere from 1,000-10,000 Å across.

Vinyl polymer molecules on the other hand do not have a stable size and shape but are flexible. In solution they exist in a rather compact form with the size and shape constantly changing. Average size, however, may be calculated as follows:

$R = 2n\ L$ where R is root mean square average end to end distance for the polymer chain, n is the number of links in the chain and L is the carbon to carbon distance in a link. Though R is not the actual diameter of the particle it is the most useful criterion of size. Using this equation we find that a 200,000 molecular weight acrylic of the type illustrated in Figure 1 would have an R of 150 Å (The sum of linkage distances in the backbone of this polymer is 7,000 Å.)

In vinyl polymers which contain ionizable groups, two important factors act to change this size. First, is the electrical repulsion of like charges along the polymer chain. In alkaline solution these polymers are ionized, causing expansion in size due to mutual repulsion of the negatively charged carboxyl ions. Degree of expansion will depend upon the number of carboxyl groups in the molecule and the pH of the solution. Molecular size under these conditions can be calculated using the following relationship developed by Flory.[2]

$$R = \sqrt{\frac{M\,[\eta]}{2.1 \times 10^{21}}}$$

where M is molecular weight and $[\eta]$ is intrinsic viscosity at the chosen pH. The constant 2.1×10^{21} has been determined for polymethacrylic acid[3] and is assumed to be a reasonable approximation of the constant for the acrylic system. Applying the calculation to an acrylic of 200,000 molecular weight containing 68 percent acid groups and 32 percent amide groups, R has a value of 2,000 Å at pH 9.5.

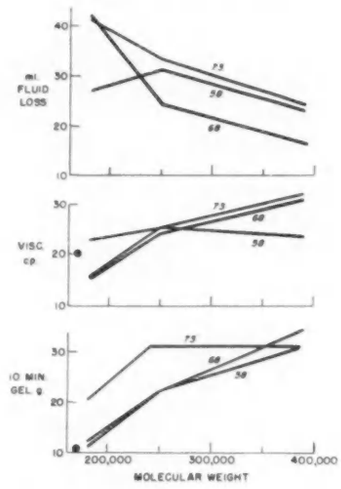
The second factor influencing the polymer size is the screening effect of other electrolytes which decreases electrostatic repulsion in solution and again allows contraction of the structure. A graphic comparison of clay and polymer particle sizes is made in Figure 6.

Examination of a bentonite (Montmorillonite) clay platelet (Figure 7)[4] shows that layers of silicon, aluminum and oxygen make up the individual platelets. Occasionally a magnesium ion (+ 2 charge) replaces an aluminum ion (+ 3 charge) and because of this the molecule as a whole carries a net negative charge that is responsible for its ion exchange properties and its colloidal behavior in solution. On the fractured edge of the platelet there also are positive sites which have been proposed as points of attraction or attachment for anions in solution. For example, thinners have been proposed to function by neutralizing positive sites and preventing them from attaching to the negative sites on other platelets. This would then prevent the buildup of a network of clay particles.

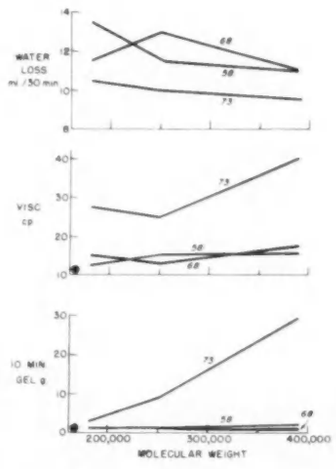
The following possible modes of action have been suggested for drilling mud additives based principally on polymer attachment at the edges of clay platelets.

- Functioning as a dispersing agent by typing up positive sites that would have been able to bond to other platelets.
- Reducing water loss by the physical blocking action of the polymer particles attached to clay.
- Increasing the viscosity of the fluid phase, thus reducing the rate of filtration.
- Acting as a linking agent between platelets. This may occur, however, only under special conditions of concentration and with certain polymer types (A).

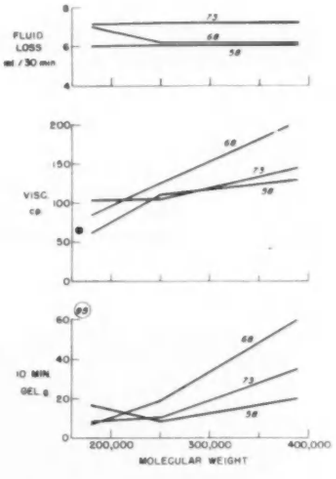
(A) As an example, it has been found that addition of certain polymers will cause a mud to go through a maximum in viscosity and gel



Saturated NaCl
Attapulgite Clay Mud
2.0 lbs./bbl. Additive



Low Solids Lime Base Mud
1.0 lb./bbl. Additive



Low Solids, Low pH, Red Mud
Contaminated with 35,000 ppm
NaCl, 1.0 lb./bbl. Additive

FIGURE 8, 9 and 10—The performance of polymer type I will vary with respective types of mud.

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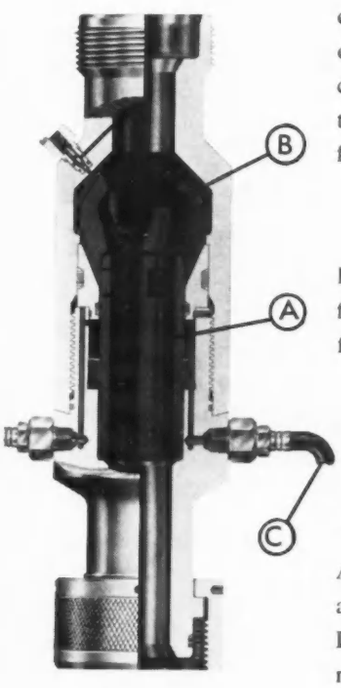

Fig. 1
Open Position

TO CLOSE (Fig. 1)

Pressure applied at Inlet (C) drives Piston (A) upward, forcing the three Rubber Covered Metal Segments (B) to form a solid, pressure tight "cone" – (Fig. 2). This closure will effect a seal around the wire line. When tools and line are out of the hole, the Segments seal tightly, completely shutting in well pressures.

TO OPEN (Fig. 2)

After opening the Equalizer Valve (E) to balance pressures above and below Segments, hydraulic pressure is applied at Inlet (D) driving the Piston (A) downward, drawing the Segments also down and outward into the recess area provided for them. This returns the tool to its full open position.

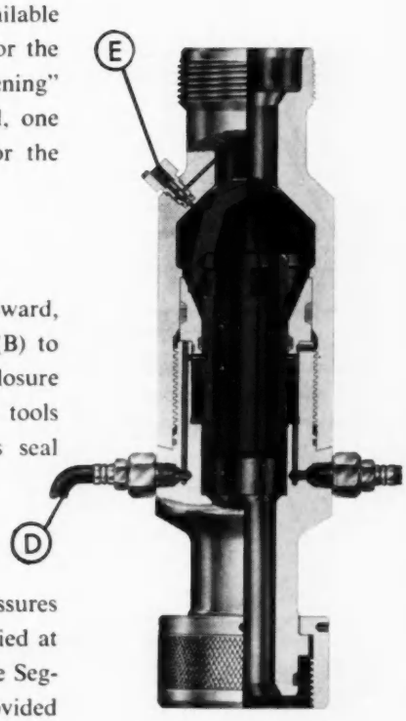

Fig. 2
Closed Position

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strength at a low polymer concentration. This viscosity decreases again as more polymer is added (see Figures 12 and 13). At low polymer concentration, interaction between clay and polymer is evidently insufficient to cause buildup of a structural network. In a critical higher concentration range however there may be extensive cross linking as evidenced by extremely high viscosities and gel strengths. As polymer concentration increases beyond this point there is an excess of polymer over the amount required to saturate the available bonding sites on the clay. A given polymer molecule, competing for a limited number of clay sites now has a much smaller chance of capturing many sites and causing network buildup.

Acrylic polymers might also act by changing the effective charge on clay particles.

While polyelectrolytes, such as the acrylics described here, have a marked effect on streaming potential measured across a clay filter cake, we have not been able to correlate this directly with fluid loss.

Effect of polymer variables upon mud systems. Two acrylic polymers were used in this study and are referred to as Type I and Type II. Type II is a hydrolyzed polyacrylamide[5] while Type I was prepared by a different method.

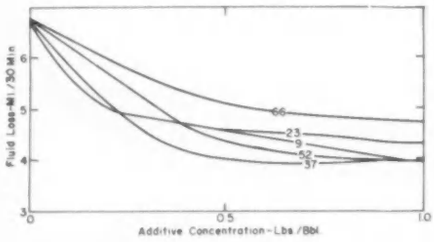
Nine Type I polymers were prepared at three molecular weights (180,250 and 390 thousand) and at three carboxylate/amide ratios, 58/42 68/32 and 73/27. The performance of these polymers in three different mud systems is illustrated in Figures 8, 9 and 10. In each of these muds, additive concentration was held constant and the effect of carboxylate/amide ratio and molecular weight was determined at this level.

In general, the effect of high molecular weight is to give better fluid loss control, but also higher viscosities and gel strengths. The effect of carboxylate/amide ratio is not as specific, and as might be expected, varies considerably with the ionic character of the drilling fluid. In the sodium chloride systems a high percentage of carboxylate gives better fluid loss control without much increase of viscosity or gel strength. In the lime base mud however, the high carboxylate content polymer gives low fluid loss but markedly higher viscosity and gel strength.

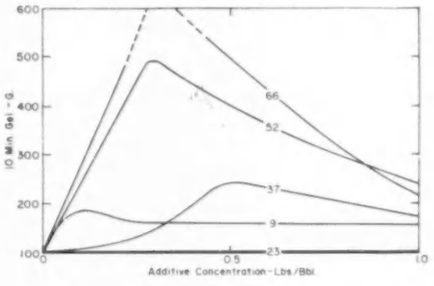
Type II polymer exhibits a different behavior in mud from that shown by Type I and has its optimum performance at somewhat lower carboxylate/amide ratios. For the work illustrated in Figures 11, 12 and 13, five preparations of Type II polymer were made at the same molecular weight (about 250,000) but with different carboxylate/amide ratios 9/91, 23/77, 37/63, 52/48 and 66/34. These polymers were compared at concentrations up to 1 pound per barrel in a high solids, low pH red mud that was picked to accentuate viscosity and gel problems. In this system, fluid loss is minimized with carboxylate contents below 50 percent, while viscosities and gel strengths are minimized at about 23 percent carboxylate. At carboxylate contents of 52-66 percent, sharp peaks in the viscosity and gel strength curves are observed at about 0.3 of a pound per barrel of additive.

These illustrations of the effect of polymer characteristics show the large number of variations that can be tailored into a molecule to produce desired properties. Often, however, a given variation will improve one property and be detrimental to another. Then it is a matter of compromising polymer structure.

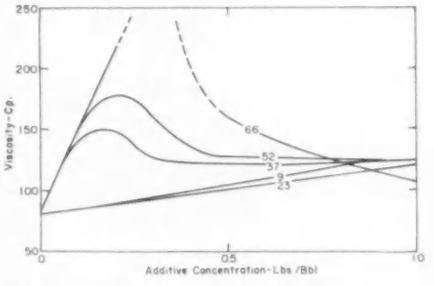
Experimentally, fluid loss determinations were standard API 30-minute tests on a filter press. Composition of polymers is indicated in the figures as percent carboxylate groups, with the difference from 100 percent being amide groups. Properties of the base mud are shown as •, or when off the graph as a circled number.



Fluid Loss As a Function of % Acid Group and Concentration.
High Solids, Low pH, Red Mud



10 Minute Gel As a Function of % Acid Groups and Concentration.
High Solids, Low pH, Red Mud



Viscosity As a Function of % Acid Groups and Concentration.
High Solids, Low pH, Red Mud

FIGURE 11, 12 and 13—The physical properties of similar muds will vary with the use of type II polymer of the same molecular weight and different carboxylate/amide ratios.

Mud Formulations Used in Test Work
(Units are lbs./bbls.)

Saturated NaCl Attapulgite Clay Mud	
Attapulgus clay	20
NaOH	0.5
In saturated salt water	
Low Solids, Lime Base Mud	
Magcogel clay	15
Quebracho	3
NaOH	3.5
Tannathin	2
Lime	10
Low Solids, Low pH, Red Mud (pH 8) Contaminated with 35,000 ppm NaCl	
X-act clay	40
Magcogel clay	5
Quebracho	2
NaOH	0.5
High Solids, Low pH, Red Mud (pH 9)	
X-act clay	60
Magcogel clay	15
Quebracho	3
Quadrafos	0.4
NaOH	1

ACKNOWLEDGMENT

Research on the effect of polymer molecular weight and carboxylate ratio on mud properties was conducted by Russell L. Morgan. The author also would like to acknowledge the assistance and helpful comments of Dr. Mary M. Miller and R. V. Logan.

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[2] Ibid, p. 611.
[3] Oth and Doty, paper presented at symposium on Polyelectrolytes, Ithaca, June 18-21, 1951.
[4] According to W. F. Rogers, "Composition and Properties of Oil Well Drilling Fluids."
[5] U.S. 2,775,557, R. L. Morgan, to American Cyanamid Co.

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May 4, 1959

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Wichita Falls, Texas

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Yours truly

Tom Cotton

Tom Cotton

Wilson

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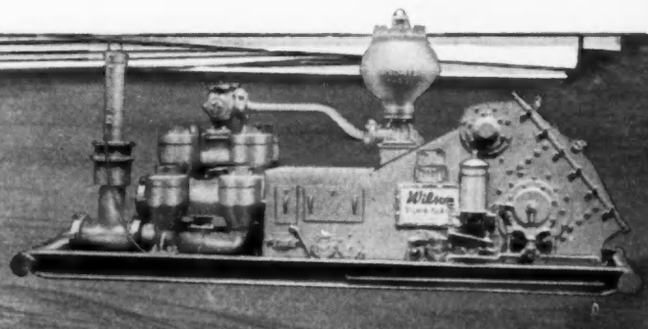

Wet gas can be metered accurately

Measurement tests with water and distillate indicate correction factors for gas streams containing mechanically entrained liquids are feasible

By Roy A. Schuster, Assistant Professor
Texas College of Arts and Industries, Kingsville, Texas

IN MEASUREMENT of natural gas by orifice meter, all factors used in the calculation of flow are based on the assumption that the gas is dry. This condition is rarely the case in field measurements. Tables in AGA Committee Report No. 3,[1] recognized as an industry standard, give no data regarding the effect that a liquid may have upon gas measurements by orifice meter. Effect of mechanically entrained liquid which may pass through the orifice plate as a mist is a subject of considerable conjecture. It is this area of measurement that has been made the subject of this investigation.

Orifice meter measurements indicate that an erroneously high differential pressure may occur when a fluid in the liquid phase is commingled with a fluid in the vapor phase.

It was believed that if the effects of a liquid upon gas measurement could be determined accurately, a correction factor could be calculated and a curve could be drawn plotting the percent error against the liquid content in applicable terms. Then, if liquid content was known, the percent of measurement error could be obtained from the curve and the recorded volume could be adjusted to more accurately indicate true volume.

Full range of tests. Full scale 3 and 4-inch orifice meter run installations were used to conduct a series of tests to determine if a correlation could be established between dry gas measurement and varying amount of liquids with regard to true measurement. Tests were run at various liquid rates, liquid specific gravities, gas rates and pressures, as well as different orifice plate sizes.

Effect of the velocity of approach to the orifice plate upon the indicated differential pressure also was considered. A 3-inch and 4-inch meter run was installed in series to determine what effect, if any, the change in velocity might have upon measurement.

Gas systems operating at 1,000 psi and 600 psi were available for the test. Inlet separators were installed on both systems. Gas was taken from the 1,000 psi system, and was passed through the test meters, and into the 600 psi system.

Pressure was varied from approximately 600 psi to 1,000 psi. Also, water of constant composition was available at 1,000 pounds pressure; water storage capacity of the separator was sufficient to permit varying the water rate over a large range.

Three meter runs used. Physical equipment consisted of three meter runs in series (Figure 1). Residue gas from the 1,000 psi inlet separator was first passed through a 4-inch meter run (Run A) which measured the dry gas. Water was taken from the inlet separator, passed through a strainer and liquid meter, and mixed with the gas at the outlet of Run A in a liquid loop. This two-phase stream then was directed through another 4-inch meter run (Run B) and into a 3-inch meter run (Run C). A water knockout was installed downstream of the final meter run.

A back-pressure regulator was used to control the pressure on the entire system and a flow controller was used to control gas volume.

Distillate apparatus. A small drip was installed ahead of the orifice plate in Run A (Figure 2) to remove any liquid in the distillate set up. When tests were run at pressures only slightly below 1,000 psi, no liquids would accumulate; however, at progressively lower pressures, hydrocarbon liquids which accumulated due to retrograde condensation would affect meter accuracy.

Flanged taps were used throughout and all meter runs met AGA requirements. Meters with a working pressure of 4,500 psi were used with a

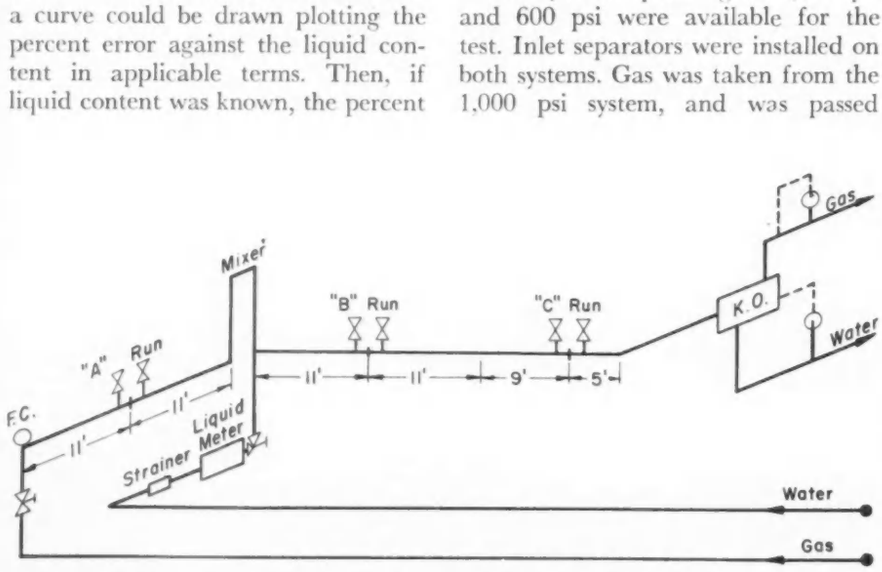

FIGURE 1—This apparatus was used to determine the effect of water in the gas stream on measurement results. The 4-inch run A was used to measure dry gas. Water was injected into the stream just prior to 4-inch run B, which was used to obtain test results. Run C (3-inch) was used to check test results.

2,000 pound spring and 100-inch differential tube. The differential tube was calibrated prior to and during the tests against a manometer. All differential readings were taken from the meter chart, but static readings were taken with a dead weight tester to the nearest pound. Specific gravity of the gas was determined with a gas balance.

Test procedure. The first series of tests were run using 1.250-inch orifice plates in all three meter runs and at a pressure slightly over 900 psi. All meters were checked with dry gas and exhibited accuracy normally accepted by industry.

Initially, a flow of approximately 1 MMcf per day was set and water was injected to the system at a low rate. After equilibrium had been established on meters B and C, simultaneous readings were taken on all three gas meters.

The water rate then was increased, and another set of readings was taken. Water rate was increased in increments until a rate of about 500 barrels per MMcf of gas was reached, readings being taken at each water rate. The water rate then was decreased in increments back to the initial rate, readings being taken at each injection rate (Figure 3). Next, gas flow was increased to slightly more than 1½ MMcf per day, and another group of tests were run at varying water rates.

At the completion of this series of tests, pressure was reduced on the system, and complete series of tests were run at incremental lower pressures.

Calculations. For gas volume calculations the basic formula $Q_h = C' \sqrt{h_w P_f}$ was used.

The orifice flow constant C′ was calculated by the equation:

$$C' = F_b \times F_r \times Y \times F_{pb} \times F_{tb} \times F_{tf} \times F_g \times F_{pv}$$

in which

F_b = Basic orifice flow factor
F_r = Reynolds' number factor
Y = Expansion factor
F_{pb} = Pressure base factor
F_{tf} = Flowing temperature factor
F_{tb} = Temperature base factor
F_g = Specific gravity factor
F_{pv} = Supercompressibility factor
F_m = Manometer factor

The above factors were obtained from tables in AGA Committee Report Number 3, except for F_b and F_{pv}.

Although the diameter of the orifice plates and the I.D. of the meter runs were well within accepted tolerances, they were not exact to 0.001 inches. Consequently, F_b factors were calculated from F_x and F_d factors.[2]

Supercompressibility factor, F_{pv}, was obtained from tables calculated from the formula given in Bulletin No. T9-354 of the California Natural gasoline Association.[3] These tables were used due to the rapidity with which the F_{pv} factors could be determined. Even if in slight error, they would have no significant effect upon final results, since the same temperature and gravity and the same pressure within five pounds were used in determining the factors. Also, an absolute pressure of 14.4 psi was used in calculating the extension.

Dry gas gravity used. Specific gravity of the dry gas was used in determining F_g on all three meters. This is an important consideration, since it was known that adding liquid water to a gas would increase its specific gravity. However, the gravity of this two-phase stream was not known. Even if it were known, no tables or formulas were available with which the specific gravity factor could be calculated.

Blank check tests run on the three meters at the start of the test did not agree entirely. Not knowing which meter was 100 percent correct, a mean volume was determined for each flow rate. From these mean volumes, correction curves were drawn for each meter and were used in making very minor corrections in the calculated volumes on each test.

From the corrected dry gas volume measured and volume of water added,

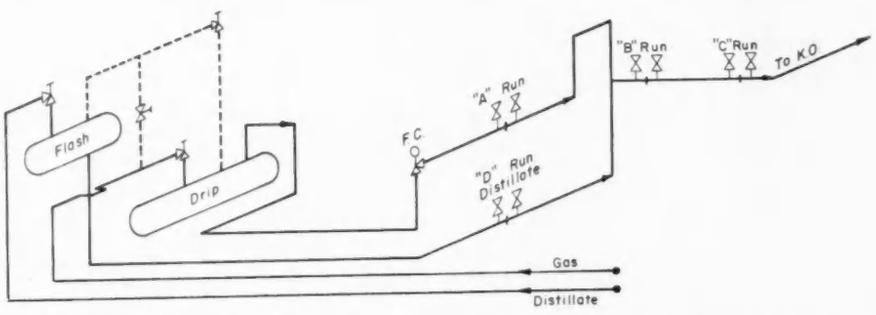

FIGURE 2—The distillate test apparatus differs from that shown in Figure 1 in that a flash tank and drip were installed on the distillate and gas lines respectively, ahead of the meter runs. Also, an orifice meter was used to meter distillate.

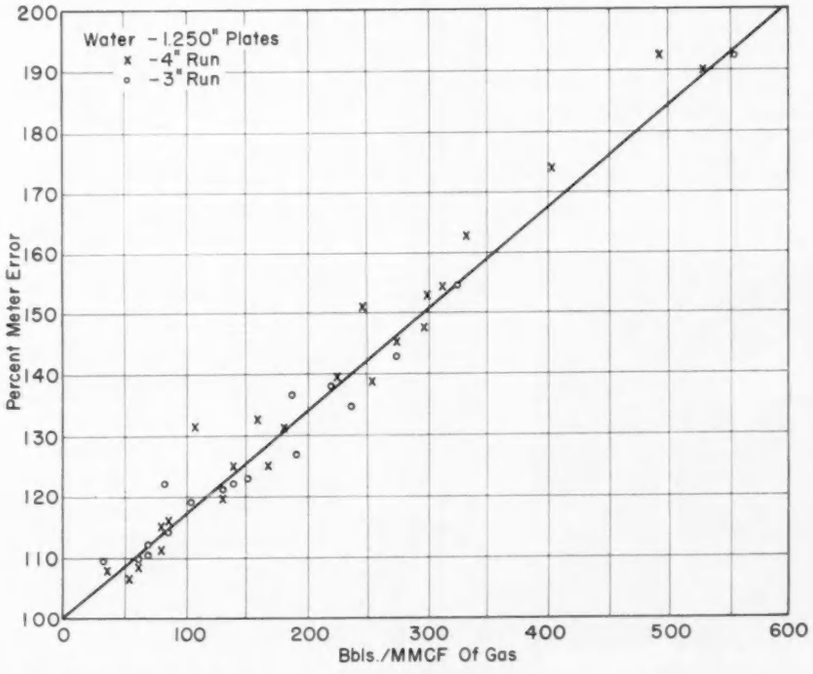

FIGURE 3—Test data obtained from the installation shown in Figure 1 was used to plot this curve. As indicated, results yield practically a straight line function for the 3 and 4-inch tests.

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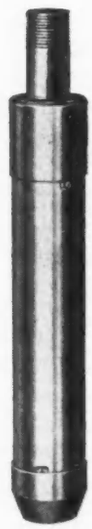

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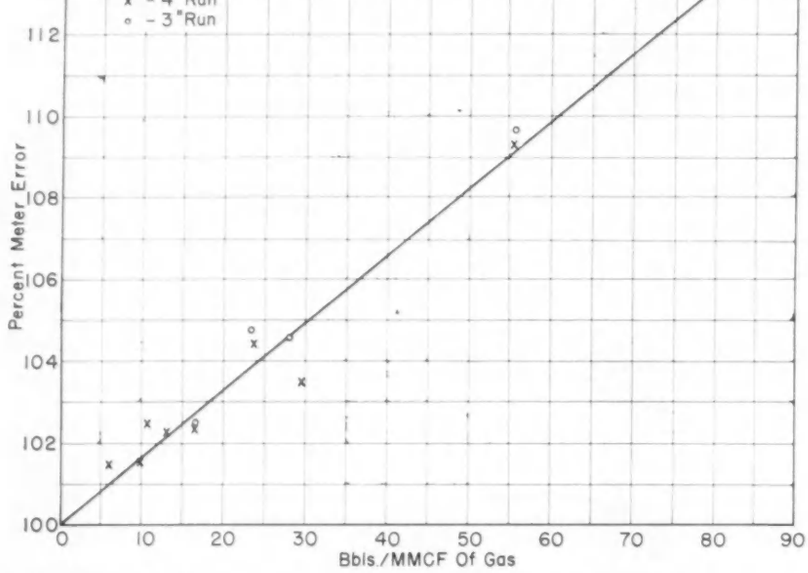

FIGURE 4—Results shown here indicate that percent meter error is correspondingly less when smaller volumes of water are entrained in the measured gas stream.

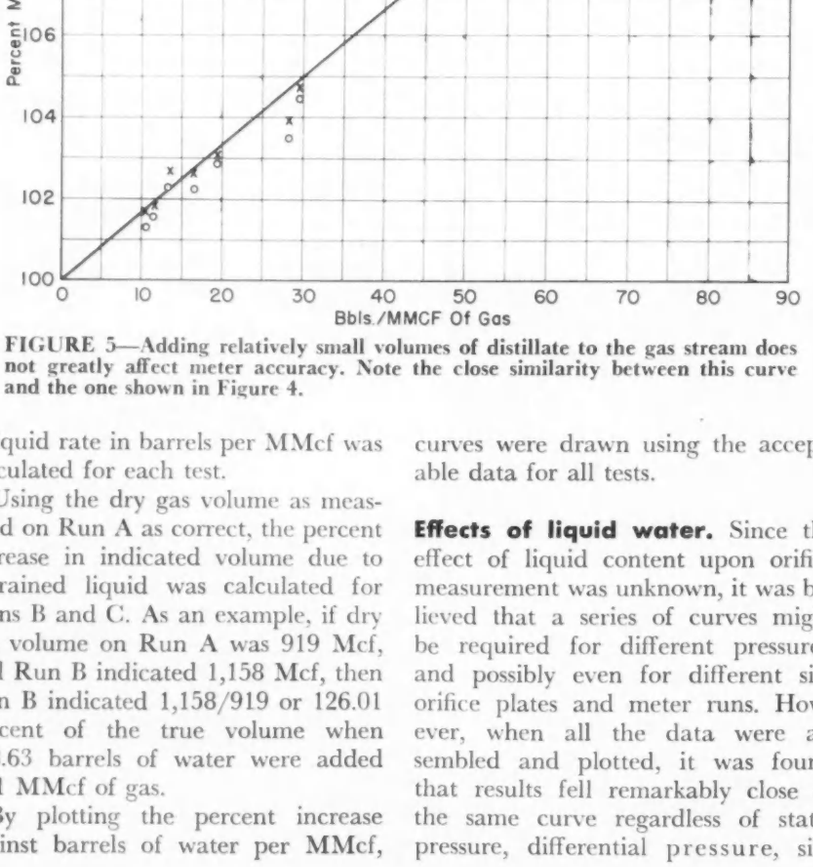

FIGURE 5—Adding relatively small volumes of distillate to the gas stream does not greatly affect meter accuracy. Note the close similarity between this curve and the one shown in Figure 4.

a liquid rate in barrels per MMcf was calculated for each test.

Using the dry gas volume as measured on Run A as correct, the percent increase in indicated volume due to entrained liquid was calculated for Runs B and C. As an example, if dry gas volume on Run A was 919 Mcf, and Run B indicated 1,158 Mcf, then Run B indicated 1,158/919 or 126.01 percent of the true volume when 168.63 barrels of water were added to 1 MMcf of gas.

By plotting the percent increase against barrels of water per MMcf, curves were drawn using the acceptable data for all tests.

Effects of liquid water. Since the effect of liquid content upon orifice measurement was unknown, it was believed that a series of curves might be required for different pressures, and possibly even for different size orifice plates and meter runs. However, when all the data were assembled and plotted, it was found that results fell remarkably close to the same curve regardless of static pressure, differential pressure, size plate, or size meter run. Further study of the figures reveals that the curve is practically a straight line function.

Because several points fell well off the curve, and extreme accuracy was desired, an orifice meter was installed on the liquid source to replace the positive displacement meter. A second series of tests then were run at considerably lower liquid rates.

Slope of curves. It was believed that if check points could be obtained at high ratios of liquid to gas, percent error would be minimized and a more accurate slope determined. Two close check points were obtained at about 550 barrels of water per MMcf of gas, and a straight line was drawn from this point to zero. This line fell on the average of other points determined on the first group of tests. Then, a line at the same slope was drawn for all other Group 2 and 3 tests run.

Effects of distillate. It was apparent at the conclusion of Group 1 tests that a straight line function was being obtained with water as a liquid. To determine what effect specific gravity of the fluid in the liquid phase would have upon the measurement, tests on distillate were run.

Since distillate was being separated at equilibrium conditions of 1,000 psi and 100° F, any decrease in pressure would cause the distillate to boil, and cause inaccuracies in the liquid meter. To remedy this condition, a flash tank was installed in the system. (Figure 2) Distillate was transferred from the 1,000 psi separator to the flash tank, and the pressure slowly reduced to allow the distillate to be flashed to the pressure at which the test was to be run. Gas was admitted to the top of the tank to force the liquid through the meter run.

Figure 5 shows results for the 1.250-inch orifice plates. Note that the same slope was used for the curve in Figure 5 that was used in Figures 3 and 4.

Figure 6 was prepared by plotting all the data obtained from Group 2 and 3 tests. This includes results at pressures of 600 and 900 psi for 3-inch and 4-inch meter runs using

1.000-inch and 1.250-inch orifice plates. Differential pressures varied from 10 to 80 inches of water and distillate rates from 6 barrels to 50 barrels per MMcf of gas. The slope used was based on 550 barrels of water per MMcf of gas; these results effected an increase in reading of 91 percent.

Reading percent correction. This same slope indicates that 85 barrels of liquid per MMcf of gas would effect an increase in reading of 14.07 percent, or one barrel would give an increase in reading of 0.1655 percent. If liquid volumes could be measured, the percent error could be determined from the curve; then the true volume of gas could be calculated by dividing the recorded volume by this factor. To simplify use of the curves, the percent correction could be plotted as the reciprocal, and the true gas volume calculated by multiplying the recorded volume by the factor.

From the data collected, it would appear that the effect of liquid commingled with gas passing through an orifice plate is not dependent upon the gravity or characteristics of the liquid. Apparently, increase in differential pressure is a function of the actual volume of the liquid passing through the plate, irrespective of the specific gravity or weight of the liquid.

When orifice plates were changed, a water mark was noted which was different from that anticipated. The level of the water ahead of the plate was lower than expected. Apparently the liquid coned up appreciably in passing through the orifice.

What test results mean. Many of the points do not fall exactly on the correction curve. However, in many cases the increase in differential pressure due to entrained liquid was very small; this resulted in calculated increases in volume of only 1½ percent. Such readings were obtained even though the accuracy of the orifice meter itself is limited to about ½ percent. All differential pressures were estimated to the nearest 1/10-inch.

Due to the large number of readings taken under various conditions with 10 barrels to 500 barrels of liquid per MMcf of gas, use of a correction factor taken from this survey should provide measurement more accurate than the gas volumes calculated with the standard gas measuring equipment in current use. Application of these test data is only as accurate as the determination of the liquid content. Additional tests and research could be run under similar conditions, using greater variations of liquid of different specific gravity.

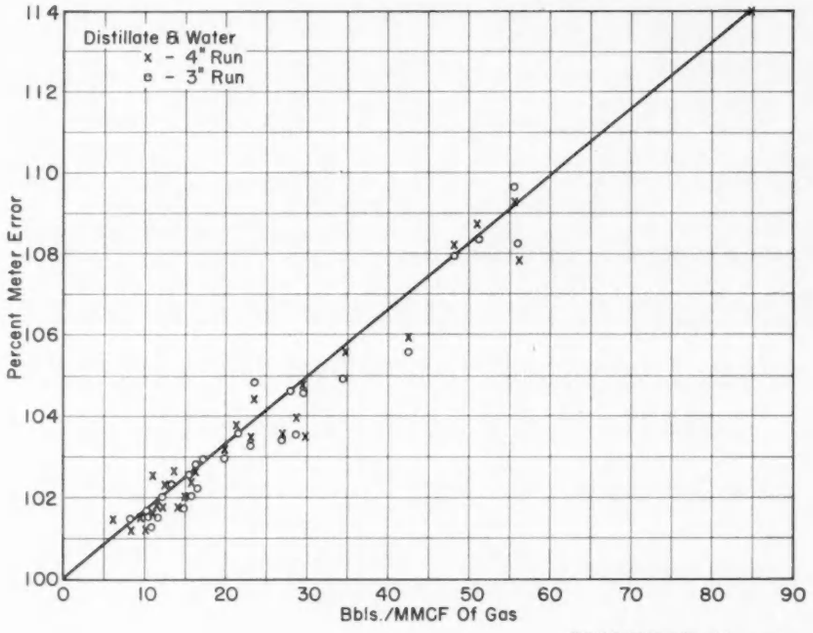

FIGURE 6—Here is a composite plot (above) of all test results obtained by injecting both water and distillate into the measured gas stream in relatively small quantities.

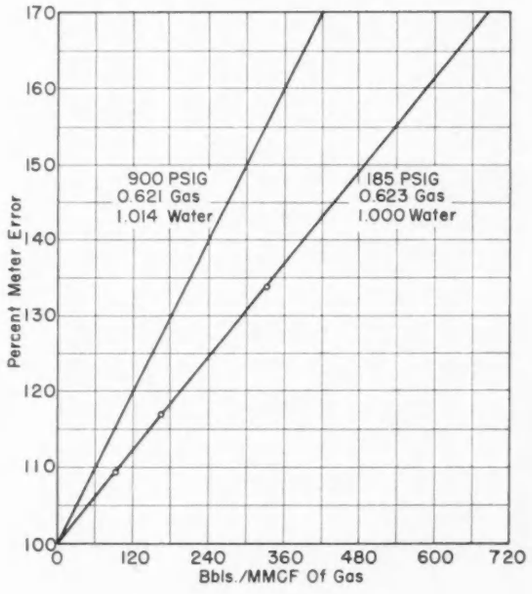

FIGURE 7—The percent meter error for a given gas-liquid ratio is much less at reduced pressure (185 psi) than in the 600-900 psi range. This variation becomes very noticeable at very low pressures and at high liquid rates.

Additional tests. Following the original tests another series was run at a pressure of 185 psi using A and B runs only. The meter was removed from the C run and installed on the B run using pipe taps to obtain a comparison between flange and pipe taps. Results indicated no difference between flange taps and pipe taps at several different liquid to gas rates.

However, it was found that the percent error due to the liquid, was less at the 185-pound pressure than in the 600- to 900-psi range (Figure 7).

Physical observations. Another run was made at atmospheric pressure, using a light shining through the downstream meter tube, to the orifice plate. The physical variation in the flow could be observed at changing differential rates. At low gas flows below 10-inches differential and low liquid rates, liquid actually flows over the plate in a small stream. At very

low liquid rates, about one barrel per million, a negative increase was shown; the differential actually decreased 1/10-inch of water.

When the differential was increased to 10 inches, flow suddenly became very turbulent. This action may account for the liquid which was found in the gage lines, particularly the downstream tap on the 3-inch meter run, during the original tests. At flows above 10 inches, the liquid passed through the plate as a mist. These latter data are so recent that no verification of the calculations nor conclusions have been made at this time.

This article is condensed from a paper presented to the 13th Annual Short course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas.

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3. California Natural Gasoline Association, Bulletin No. TS-354.
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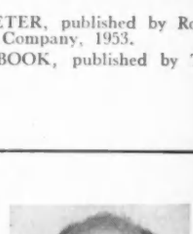
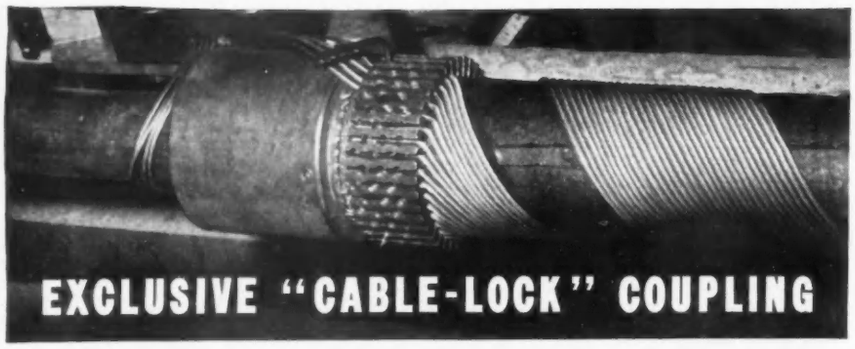
About the Author



Roy A. Schuster has over 30 years experience in the natural gas industry. On graduation from Case Institute of Technology with a B.S. degree in chemical engineering in 1929, he became associated with the subsidiary companies of the Columbia Gas and Electric Corporation in the natural gasoline division. In 1945 he joined the Chicago Corporation as manager of plants. This long experience with the gas industry from research to operations led to the vocation of a professor; he joined the staff of the Division of Engineering at Texas College of Arts and Industries in 1957. In the Department of Petroleum and Natural Gas Engineering Schuster devotes research and teaching efforts to the fields of materials of engineering and the production and measurement of natural gas.



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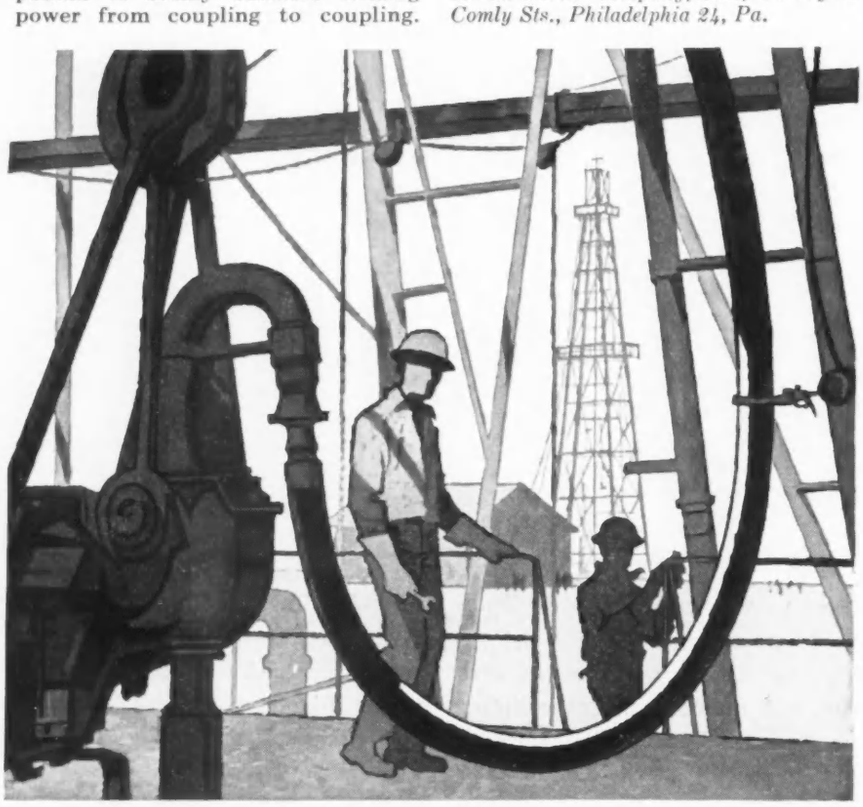

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Whitney M. Elias

G. H. Galloway

Pan American Petroleum Corporation has announced the following executive changes involving new assignments for three officials. **Charles F. Bedford**, Tulsa, formerly vice president—production and a director, moved to Fort Worth as vice president, director and division manager of the North Texas-New Mexico division. **Whitney M. Elias,** formerly vice president, director and division manager of Pan Am's Texas-Louisiana Gulf Coast division at Houston, returns to Tulsa replacing Bedford. **George H. Galloway,** currently vice president of the firm's Canadian division, moves to Tulsa as vice president—exploration and a director.

C. F. Bedford

Loffland Brothers Company, Tulsa, has appointed **Lee A. Pease** head toolpusher of Canadian operations. Pease will assist **Paul L. Waid,** who is superintendent of operations of the drilling program in Calgary, Alberta, Canada. **Dewey E. Williams** has been appointed superintendent in charge of the Argentine operations. He will headquarter in Buenos Aires.

H. W. Haight has resigned as president of **Creole Petroleum Corporation** and has been named chairman of the board of **The Carter Oil Co.** He plans to move to Carter headquarters in Tulsa. **John W. Brice,** in his capacity as president, will continue as Carter's chief executive officer. Haight served as president of Creole since 1954 with headquarters at Caracas, Venezuela. **Arthur Proudfit** succeeds Haight as president of Creole.

G. C. Hardin, Jr.

Thomas D. Barber

George C. Hardin, Jr., has been promoted to general manager of all the **Michel T. Halbouty** oil and gas activities. Hardin is the author of many papers on the geology of fluorspar deposits in southern Illinois, western Kentucky and on the geology of oil fields in Texas, southern Arkansas and northern Louisiana. It has also been announced that **Thomas D. Barber,** former assistant division exploration superintendent for the Pan American Petroleum Corporation, has joined the Halbouty organization as manager of exploration, supervising all geophysical and land matters.

B. M. Moroney, former division engineer for Gulf Refining Co., has joined **J. A. Halpine & Son, Inc.,** at Tulsa. He will head the newly formed activity of consulting work for production, transportation and equipment development.

PEPA Names Coffman President

D. S. Coffman (center), Texas Power and Light Co., Dallas, was named president of the Petroleum Electric Power Association at the group's 31st annual meeting recently in Galveston. W. M. Larkin (left), Gulf States Utilities Co., Lake Charles, La., was named vice president. B. F. Thompson (right), Public Service Company of Oklahoma, Tulsa, is the new secretary.

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The Pure Oil Company has established a new foreign operations department as part of its exploration and production division and has appointed **Glen R. Harsh** as its head.

Fred G. Crosby has been elected to the board of directors of **Sun Oil Company, Limited,** according to a recent announcement.

George P. Mitchell

Christie, Mitchell & Mitchell Company has announced that **George P. Mitchell** is the new president of the firm. Mitchell, a geologist and petroleum engineer, succeeds his brother, **Johnny Mitchell,** who becomes vice chairman of the board, in the presidency.

H. W. Straley, III, has severed all other commercial connections to devote full time to leading the activities of the Mineral Engineering Group, Material Sciences Division, Engineering Experiment Station, **Georgia Institute of Technology,** Atlanta, Ga.

Fred L. Oliver & Associates, petroleum consultants, have recently completed the move to their new offices at 211 North Ervay, Suite 1414, Dallas.

W. C. Wagner, district geologist for **Pan American Petroleum Corporation,** has been transferred from Shreveport, La., to Jackson, Miss.

Robert O. Albert has been transferred to Santa Barbara, Calif., as manager of the new laboratory of **Petroleum Technologists, Inc.**

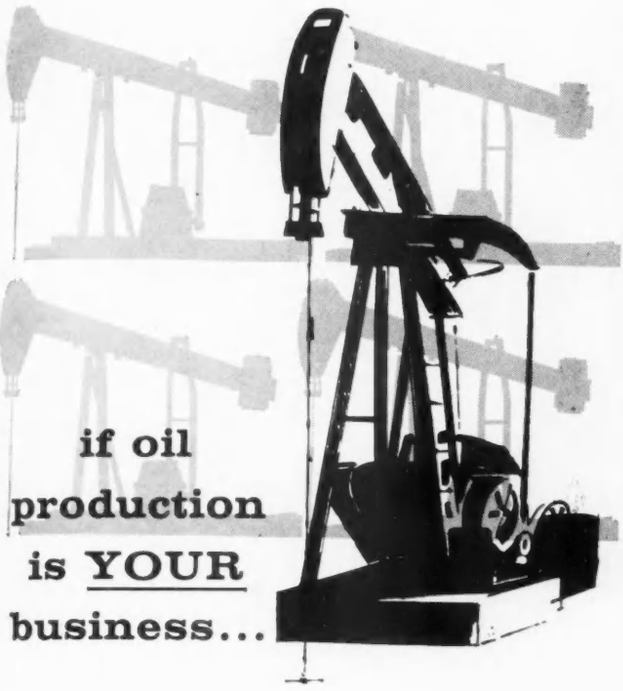
Texaco's Producing Department, Houston division, has announced the following changes in the exploration group: **L. A. Kuebler,** former Houston geologist has been promoted to the position of assistant division geologist; **Ralph A. Davis** and **Morris W. Wylie** have been appointed district geologists for the coastal counties lying between the Sabine River on the east and Refugio County on the west of Houston. **Claude M. Watts** succeeds Davis as development geologist on the division geologist staff.

William D. Crews

William D. Crews, formerly project leader in the geophysical section of **Cities Service Research and Development Company,** Tulsa, has resigned to open his own consulting office in that city. He will specialize in secondary recovery, exploration and radioactivity surveying.

Ford, Bacon & Davis, Inc., engineers and business consultants marked its 65th anniversary by moving into new and larger quarters in the new building at 2 Broadway, New York.

Howard Warren, of the Houston oil firm **Ginther, Warren & Company,** was elected to the presidency of the **Petroleum Club** at the club's annual meeting.



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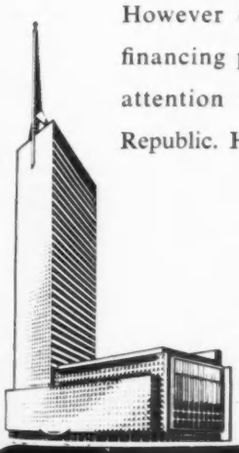

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The British-American Oil Producing Company has announced several promotions and transfers of production and engineering personnel. **George W. Murphy**, promoted from assistant chief engineer of the Engineering Section to assistant general superintendent of the Operation Section will remain in Dallas. **John E. Stein**, formerly Northwestern District Engineer, Denver, replaces Murphy. **Earl W. Rogers** was promoted from field superintendent at Marlow, Okla., to Northwestern District engineer. **Jack Sherrod** replaces Rogers at Marlow. Other promotions include **John D. Freeman** from field engineer to field superintendent, Sterling, Colo.; **J. D. Horne** from production foreman, Riverton, Wyo., to field engineer in Sterling; **Otto Wink** from production foreman in Kimball, Nebr., to senior production foreman in Riverton.

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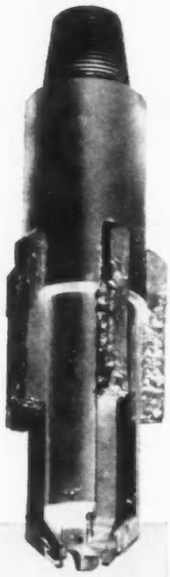

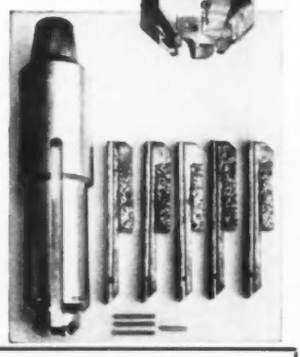

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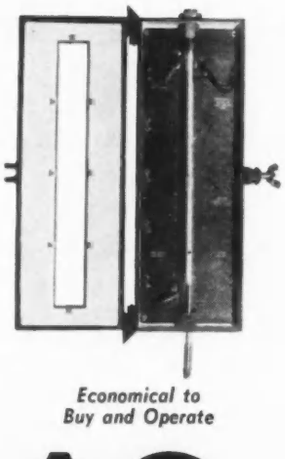

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William O. Clift

A. F. MacLeod Matthews

Sinclair Oil Corporation and **The British Petroleum Company Limited** have announced the organization of a jointly owned company to engage in crude oil exploration and production ventures in Latin America. The new company, **Sinclair and BP Explorations, Inc.**, will be headed by **William O. Clift**, president and chief executive officer, and **A. F. MacLeod Matthews**, senior vice president.

Standard Vacuum Oil Company has announced the appointment of **Robert W. Wales**, Southport, Conn., as general counsel. He replaces the retired **Warrack Wallace.**

Clifford L. Wise replaces **Marion F. Bolton** as manager of operations for **Kerr-McGee Oil Industries, Inc.**, at Shiprock, N. M. Bolton has been named general manager of operations for **Kermac Nuclear Fuels Corp.**, at Grants, New Mexico.

James E. Finley, exploration manager for **Continental Oil Company's** southwestern region, has been selected from American industry to receive a **1959-60 Sloan Fellowship** at the Massachusetts Institute of Technology, Cambridge, Mass. At the same time, Continental Oil announced the promotion of Finley from southwestern region manager to regional general manager.

James E. Finley

William H. Hawn, independent oil producer from Corpus Christi, Texas, has been elected to the board of directors of **Cosden Petroleum Corporation.** He replaces the late **Leo M. O'Neil.**

J. Frank Rollins has been elected president of **Rayflex Explorations, Inc.**, foreign operating subsidiary of **Rayflex Exploration Company** of Dallas.

John J. Wanner, district engineer for **Kirby Petroleum Company**, Denver, has resigned that position and has opened an office in Denver as a consulting petroleum engineer.

Magnolia Petroleum Company has announced the election of two vice presidents and the creation of a petroleum chemicals department. **L. E. Frensley**, comptroller, was named a vice president, as was **E. J. Wacker, Jr.**, now an assistant vice president. The petroleum chemicals department will be under the direction of **R. D. Hanley**, vice president and manager of the natural gas department.

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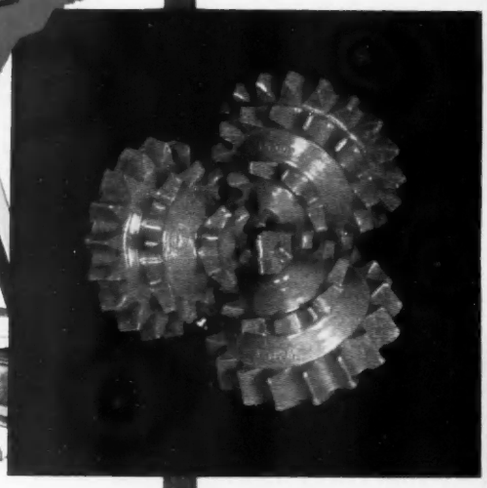
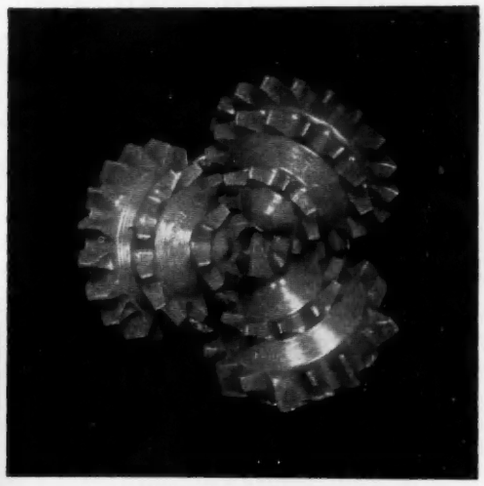


M4N

FORMATION RATINGS: For shale, lime, sand, shaley lime, and other medium to medium hard formations.

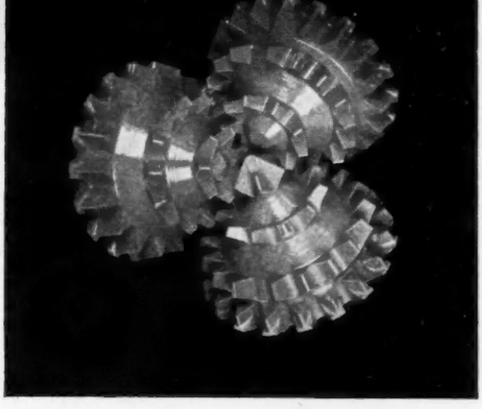
SIZES: 23 bit sizes from 5⅝ inches to 12¼ inches



M4

FORMATION RATINGS: For hard lime, hard shale, hard sands, anhydrite, dolomite, and other medium hard to hard formations.

Sizes: 23 bit sizes from 5⅝ inches to 12¼ inches



M4L

FORMATION RATINGS: For medium hard-abrasive to hard formations where hard lime, dolomite, and chert streaks predominate.

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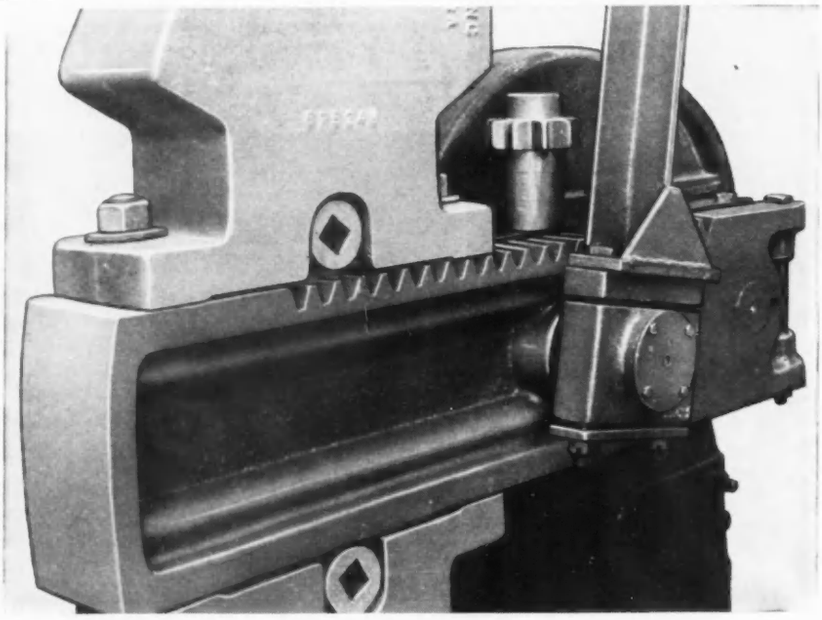
D. R. Hagerman

R. G. P. Maclellan

Canadian Husky Oil Ltd. has announced the appointment of **D. R. Hagerman** as treasurer and **R. G. P. Maclellan** as secretary of the company. Both positions were formerly held by **A. Larsen** who is also vice president—finance of the company.

The Ohio Oil Company has announced that two production officials will exchange positions in the near future as a part of a rotation program designed to give domestic production officials foreign experience. **W. T. Kennedy,** Los Angeles division superintendent of production, will transfer to Tripoli, Libya, as operations manager of the **Oasis Oil Company of Libya,** a wholly owned subsidiary of Ohio Oil. **R. C. Farley,** operations manager in Libya, will assume Kennedy's position in the domestic group.

R. (Cotton) Makin, formerly president of Makin Drilling Company, has withdrawn from the contract drilling phase of the oil industry. He will now devote his time to the management and exploration of oil and gas properties for individuals, groups, or companies.



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WHO'S MEETING WHERE

AUG. 10–13	SAE, National West Coast Meeting, Hotel Georgia, Vancouver, B.C.
12–15	Billings Geological Society Field Conference, Great Falls, Monta.
23–26	AIEE, 6th Electrical Conference of the Petroleum Industry, Wilton Hotel, Long Beach, Calif.
26–28	21st Technical Conference on Petroleum Production, Pennsylvania State University, Philadelphia, Penn.
31–Sept. 2	AIME Conference on Semiconductors, Institute of Minerals Division, Statler Hotel, Boston, Mass.
SEPT. 10–	Oil Trades Association of New York, Westchester Country Club, Rye, N.Y.
10–	Oil Trades Association, Annual Meeting, Hotel Ambassador, Los Angeles.
14–16	Texas Mid-Continent Oil & Gas Association, 40th Annual Meeting, Rice Hotel, Houston.
15–17	Texas Mid-Continent Oil & Gas Association 40th Annual Meeting, Rice Hotel, Houston.
16–18	National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City, N.J.
20–23	ASME, Petroleum Division, Petroleum Mechanical Engineering Conference, Rice Hotel, Houston.
24–25	Louisiana-Arkansas Division of Mid-Continent Oil & Gas Association, Annual Meeting, Roosevelt Hotel, New Orleans.
27–29	National Association of Oil Equipment Jobbers, Annual Convention and trade show, Hotel Leamington, Minneapolis, Minn.
27–30	API, Executive Committee of Board of Directors, Greenbriar Hotel, White Sulphur Springs, W. Va.
28–30	American Petroleum Credit Association, 35th Annual Conference, Radisson Hotel, Minneapolis, Minn.
29–Oct. 1	NACE, Western Region Conference, Bakersfield, Inn, Bakersfield, Calif.
OCT. 1–2	NACE, Southeast Region Conference, Jacksonville, Fla.
4–7	Society of Petroleum Engineers of of AIME, 34th Annual Fall Meeting, Dallas.
5–7	NACE, Northeast Region Conference, Lord Baltimore Hotel, Baltimore, Md.
8–10	AAPG, 2nd Annual Meeting of the Southwestern Federation of Geological Societies, Lubbock, Texas.
11–13	AAODC, 19th Annual Meeting, Skirven Hotel, Oklahoma, City.
20–22	NACE, North Central Region Conference, Cleveland, Ohio.
21	Oil Trades Association of New York, Meeting, Waldorf-Astoria Hotel, New York City.
22–23	Society of Petroleum Engineers of AIME, Los Angeles Basin Section, Fall Meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
28–30	AAPG, Mid-Continent regional Meeting, Broadview Hotel, Wichita, Kan.
29–30	Oil Recovery Symposium on Southwest Texas, Corpus Christi.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

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57	4 1/2" to 13 3/8"	to 8,000 ft. lbs.
58	1 1/2" to 5 1/2"	to 4,000 ft. lbs.
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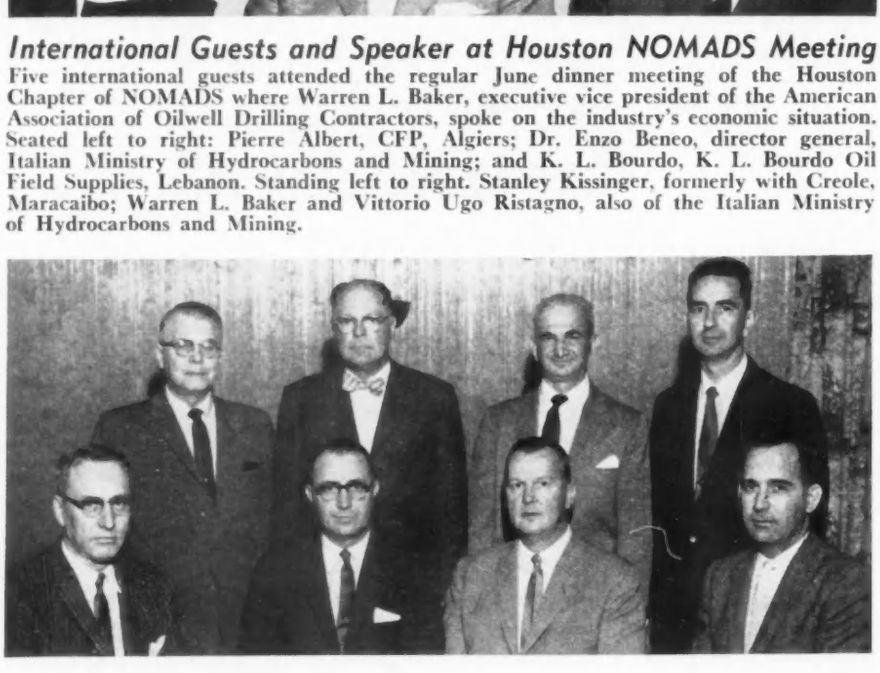
what's Happening

among INDUSTRY ASSOCIATIONS

International Guests and Speaker at Houston NOMADS Meeting

Five international guests attended the regular June dinner meeting of the Houston Chapter of NOMADS where Warren L. Baker, executive vice president of the American Association of Oilwell Drilling Contractors, spoke on the industry's economic situation. Seated left to right: Pierre Albert, CFP, Algiers; Dr. Enzo Beneo, director general, Italian Ministry of Hydrocarbons and Mining; and K. L. Bourdo, K. L. Bourdo Oil Field Supplies, Lebanon. Standing left to right. Stanley Kissinger, formerly with Creole, Maracaibo; Warren L. Baker and Vittorio Ugo Ristagno, also of the Italian Ministry of Hydrocarbons and Mining.



New Officers for Illinois Oil & Gas Association

The following officers were elected for the coming year at the Illinois Oil & Gas Association 14th Annual Meeting held in Mt. Vernon, Ill. Front row, left to right: J. D. Anderson, third vice president, Ohio Oil Co., Terre Haute, Ind.; H. L. Brockman, president, Calvert Drilling Inc., Olney, Ill.; Thomas N. Duncan, retiring president, N. V. Duncan Drilling Co., Fairfield, Ill.; F. F. Farrar, secretary, Farrar Drilling Co., Mt. Vernon. Back Row, left to right: Walter B. Price, treasurer, National Associated Petroleum Co., Mt. Vernon; C. T. Smith, general counsel, independent producer, Flora, Ill.; Joseph J. Shulman, second vice president, Shulman Bros., Vandalia, Ill.; C. J. Pardee, executive secretary, Mt. Vernon; not present but elected First Vice President, M. H. Guess, Shell Oil Company, Centralia, Ill.

Mid-Continent Section of AIME Elects W. E. Stiles as Chairman

William E. Stiles of Stiles Engineering, Tulsa, has been elected chairman of the Mid-Continent Section, Society of Petroleum Engineers of AIME for 1959-60, succeeding John E. Eckel of Jersy Production Research Company, Tulsa.

Other officers include Virgil J. Berry, Jr., Pan-American Petroleum Corporation, first vice president; H. A. Nedom, Amerada Petroleum Corporation, second vice president; C. L. Wilson, Sinclair Oil and Gas Company, secretary; F. M. Stewart, Alex McCoy Associates, treasurer.

Daniel A. Busch Recipient Of Geo. Matson Award by AAPG

Daniel A. Busch, consulting geologist, of Tulsa, has been chosen by the American Association of Petroleum Geologists to receive the George Matson award at the AAPG's annual convention next year in Atlantic City, N. J.

Busch is the third winner of the award given for the presentation of the best technical paper at an annual meeting. The winning paper was presented at the Dallas meeting in March and was entitled, "Prospecting for Stratigraphic Traps."

Claude V. Barrow
Assoc.

Paul S. Hedrick
Assoc.

OIPE Cite Two Oil Industry Writers for Past Contributions

Paul S. Hedrick, long-time oil editor of the *Tulsa World* and now oil consultant for the World, and Claude V. Barrow, oil editor of the *Daily Oklahoman* since 1926 were cited for their contributions to the industry through the written word and received parchment commendations on behalf of the Oklahoma Independent Petroleum Association.

Recognition of these pioneer Oklahoma oil editors was part of the observance at Bartlesville, Okla., marking the 62nd anniversary of Oklahoma's first commercial oil well. The two senior editors were recognized for developing the oil writing style now used by newspapers throughout the work. They standardized the designation of a well, its location and its progress status now universally used.

Dallas-Fort Worth Nomads Set Tuesdays for Luncheon Meet

The Dallas-Fort Worth Chapter of NOMADS have instituted Tuesday luncheon meeting to be held on the first and third Tuesdays of each month for exchange of current foreign travel information.

These meetings, strictly informal, will be held at the Crossroads Restaurant on the Dallas-Fort Worth Turnpike near Arlington on each meeting day. Those NOMADS in the area and any and all foreign travelers will be welcome.

What's Happening among SERVICE and SUPPLY MEN

R. B. Hyde, Jr.

J. N. McCaskill

R. B. (Buddy) Hyde, Jr., has been promoted from chief service engineer of the Drilling Mud department to the newly-created position of Export Sales manager of the Foreign Operations department of **Magnet Cove Barium Corporation. James N. McCaskill** succeeds Hyde in the Drilling Mud department as chief engineer. Both men will continue to make their headquarters in Houston.

Pathfinder Oil Tool Company has recently changed the name to the present title. The company previously had been known as **Oil Country.** Headquarters for Pathfinder Oil Tool Company is in Houston.

Lloyd W. Holloway has been named store manager at Refugio, Texas, for the **Mid-Continent Supply Company.** He is a graduate of the University of Houston where he received a BBA degree in 1952.

R. D. Fagan has been transferred to Dowell's Technical Services and Development department with the title of engineer. He will have his office in the First City National Bank Building, Houston. In his new assignment, Fagan will be responsible for the development of Dowell's cementing services on the Gulf Coast and in the Permian Basin. He will report to **Joseph B. Stewart,** manager of the Company's Technical Services and Development department in Tulsa.

R. D. Fagan

Servco has announced completion of a major personnel realignment program in the Gulf Coast area. **Leo Franques** is now general manager of Gulf Coast operations; **Marc Loy** has been appointed general sales manager of the Gulf Coast area; **Jim McCaskill** is the new manager of Texas operations, and **Dick Boothe** is now manager of Louisiana operations.

Henry C. Tooley has been appointed plant manager for the Missouri City plant of **W-K-M, Division of ACF Industries,** Incorporated. In his new position, Tooley will be responsible for all manufacturing functions at the plant and will report to **R. O. Wynn,** vice president, manufacturing.

The Parkersburg Rig & Reel Company, Division of the Parkersburg-Aetna Corporation, has announced the appointment of **Craig M. Rowley** as executive vice president and general manager.

F. W. Laverty

J. N. MacKendrick

Joseph J. Rosecky

F. W. Laverty has been appointed the new president of **Clark Bros. Co.,** it has been announced. **Joseph J. Rosecky** has been appointed executive vice president succeeding Laverty. **J. N. MacKendrick,** president of Clark Bros., until the present time, was appointed chairman of the board. Clark Bros. is one of the **Dresser Industries.**

Hammond A. Helms of Dallas, has been elected vice president and general manager of the **Baash-Ross Division of Joy Manufacturing Company.** He succeeds **G. D. Johnson,** who continues as a consultant to the company.

G. K. Viall has recently been appointed senior vice president of **Chain Belt Company** at a recent meeting by the firm's board of directors. He previously has served as chief engineer of the Chain Division; assistant to the president; Works manager; and vice president. He established the firm's Planning department and the Research and Development section.

G. K. Viall

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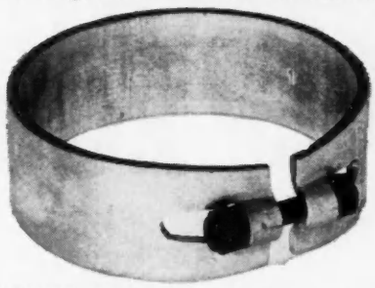

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For more data on advertised products, use Readers' Service Cards, last page.

Jim Rea

American Iron & Machine Works Company has announced the promotion of **Jim Rea** to district manager, with headquarters in New Orleans. Prior to his promotion Jim was a special representative for American Iron in Tulsa. He was transferred to Tulsa from Great Bend, Kans., where he was sales representative for the western half of Kansas.

Thomas N. Shults has been elected president of **Mid-Continent Supply Co.** at Fort Worth, succeeding **D. H. Thornbury** who has been elected chairman of the board and chief executive officer. Other changes include. **L. T. Ratliff**, Tulsa division manager has been named New York office export manager; **C. H. Hickman**, formerly Wichita Falls, Texas, division manager has moved to Tulsa; **P. Z. Hilliard**, general division manager was promoted to vice president; **R. L. McAnally** was promoted from sales manager to division sales manager at Denver; **J. O. Ramsey** from assistant division manager to manager at New Orleans; **J. L. Voss**, Houston division sales representative to Houston division manager; **W. W. Arnold**, former Denver manager to manager at Midland, Texas; **R. S. Weilman**, former Houston manager, to division manager at Wichita Falls; **L. B. Levell**, formerly assistant sales manager at Fort Worth has been named Mid-Continent agent in Latin America.

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A. D. Rose

A. D. Rose was elected president of **Jas. P. Marsh Corp.** by the board of directors at a recent meeting. Rose was formerly executive vice president. He organized the company's first engineering and development department and his name appears on many patents granted to the firm.

United States Rubber Co. has announced the appointment of **Eugene D. Conroy** as sales engineer for the battery separator department.

National Supply Company has announced three changes in its Export Division. **A. Robert Meyer**, vice president, will function in a staff capacity, devoting his attention to foreign manufacturing and licensing and the broad development of the company's international activities. **Calvin B. Carter** has been appointed division manager of the Export Division. **James M. Davies** will succeed Carter as division sales manager.

John C. Stick

Well Surveys, Inc. has announced the appointment of **John C. Stick** as technical director. He has been acting technical director for the past six months. He previously held the position of chief electrical engineer.

William J. Hamley has been appointed production control supervisor of **A. M. Byers Company's** South Pittsburgh plant.

American Cyanamid Company has announced the appointment of **R. C. Sarfaty** as assistant manager of advertising.

Carl J. Maki, formerly of The Texas Company, has filled a new post at **Dresser Industries, Inc.**, assistant to the executive president.

Joe W. Bull was recently appointed sales manager of all Canadian operations for **Milwhite Mud Sales Company, Ltd.** He will make his headquarters in Calgary, Alberta, Canada.

Jack B. Fleming

Jack B. Fleming, Welex vice president, formerly in charge of the Texas and Louisiana Gulf Coast Divisions, has been named vice president in charge of **Welex of Canada, Ltd.**, at Calgary, Alberta. Welex also recently announced the promotion of **Harry R. Pegors**, former field engineer, to district manager at Bakersfield, California.

Stanley D. Strand as area manager, tubular sales, Calgary, Alta., for **U.S. Steel's Oil Well Supply Division** has been announced.

Bill C. Robinson

W. C. Norris Manufacturer, Division of Dover Corporation, Tulsa, has announced the opening of a branch warehouse at Edmonton, Alberta, Canada, under the supervision of Canadian Division Manager **Bill C. Robinson.** Warehouse manager is **Otto R. Perryman.**

Elmer L. Estes has recently been assigned to sales by **Union Wire Rope Corporation** with headquarters at the corporation's office and warehouse in Houston.

Caran Engineering Corporation has announced the election of **Jack H. Ragsdale** as a vice president. He has served as well logging manager for the South Texas-Gulf Coast district of the Caran companies.

J. E. Kelley, formerly of **Southern Engine & Pump Company's** Dallas office, has been transferred to Corpus Christi, Texas, as manager of the new SEPCO branch office. **N. M. Shuyler, Houston,** is now in Corpus Christi and in charge of the Service Department.

Martin Wheeler

Martin Wheeler has recently joined the **Milwhite Mud Sales Company** in Oklahoma City as their sales representative in the Oklahoma City area. Wheeler formerly was associated with the Fox Rig and Lumber Company.

Glenn Doggett has been named area sales manager for **GO Oil Well Services'** new Abilene, Texas, branch. The company headquarters in Fort Worth and has other branches throughout the Southwest.

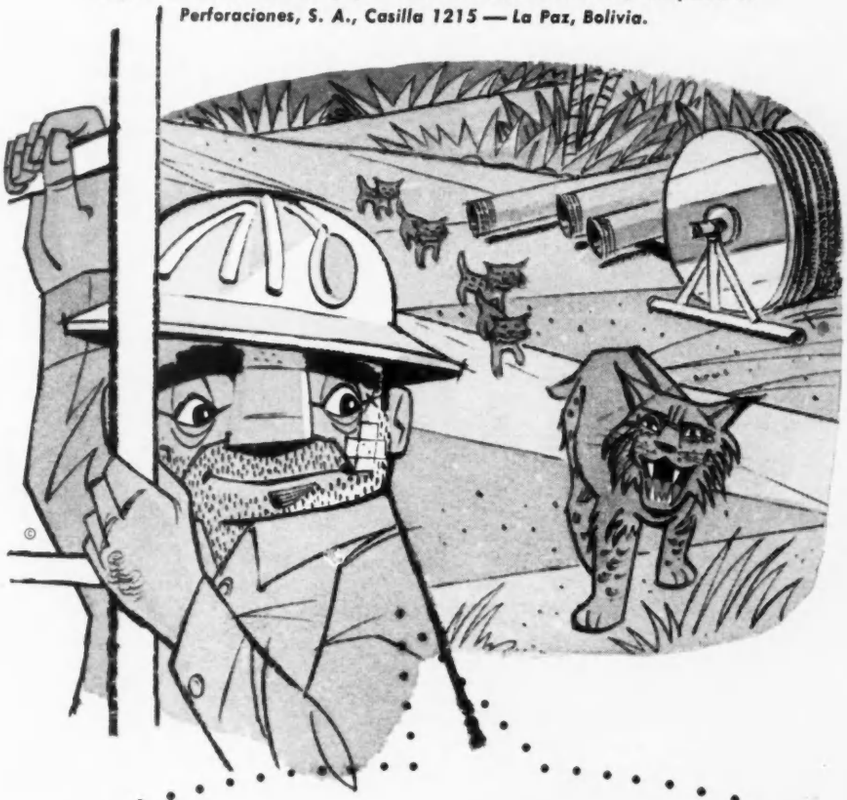
United States Steel Corporation has announced the following appointments within its **Oil Well Supply Division. James E. Chenault, Jr.,** as district manager at Edmonton, Alta; **Howard Rainbird** as area representative at Calgary; **Charles V. Black** as store manager at Abilene, Texas.

W. A. Davidson

W. A. (Bill) Davidson has been appointed general sales manager at **Herb J. Hawthorne, Inc.,** Houston. In the fall of 1958 Davidson was advanced to assistant sales manager at Hawthorne, as the company's marketing activities expanded.

James M. Bird, vice president of **Seismograph Service Corporation,** has been elected to the SSC board of directors.

Congrats and $25 for this quip to FABIO SORIA GALVARRO, Compañia de Perforaciones, S. A., Casilla 1215 — La Paz, Bolivia.



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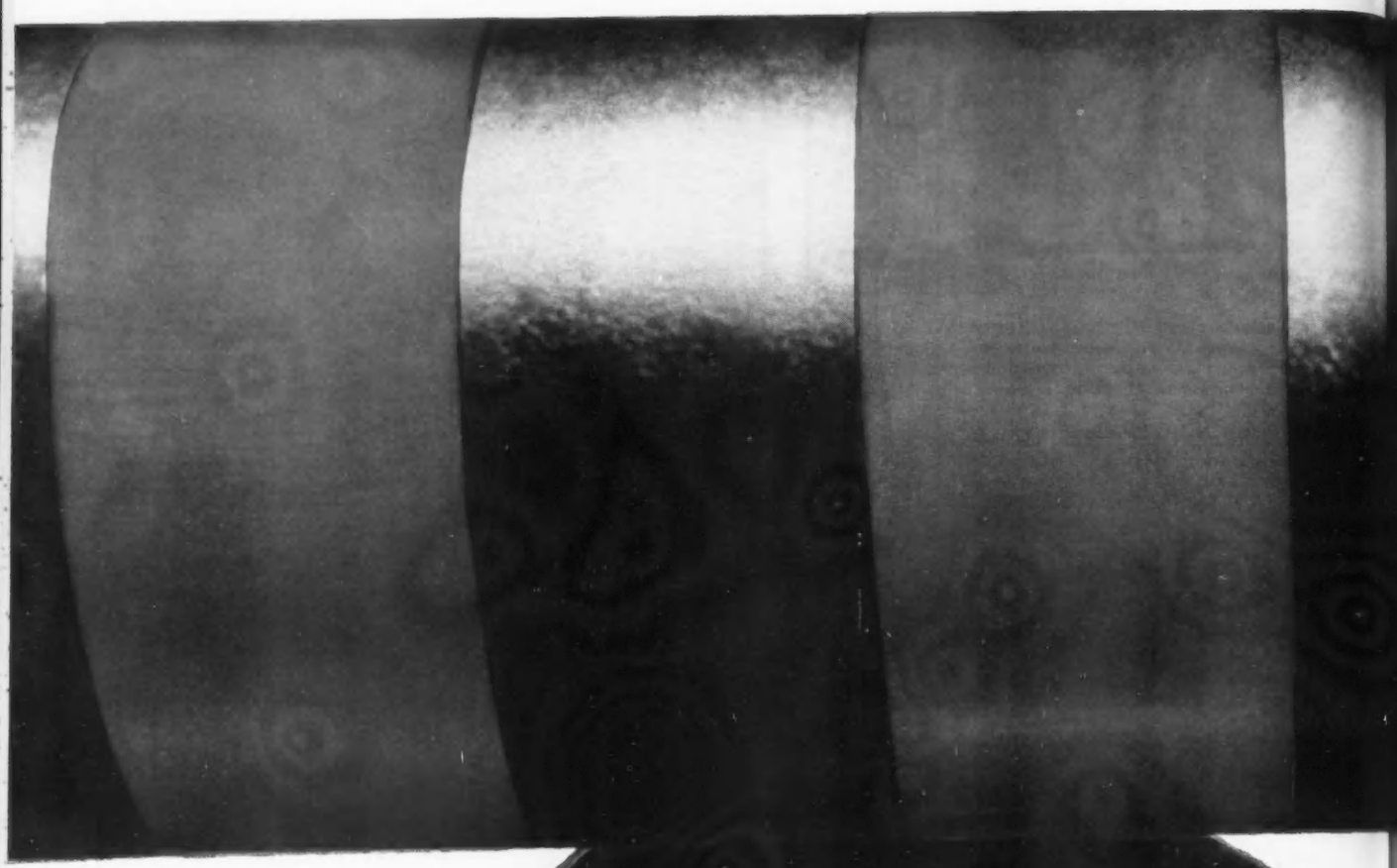

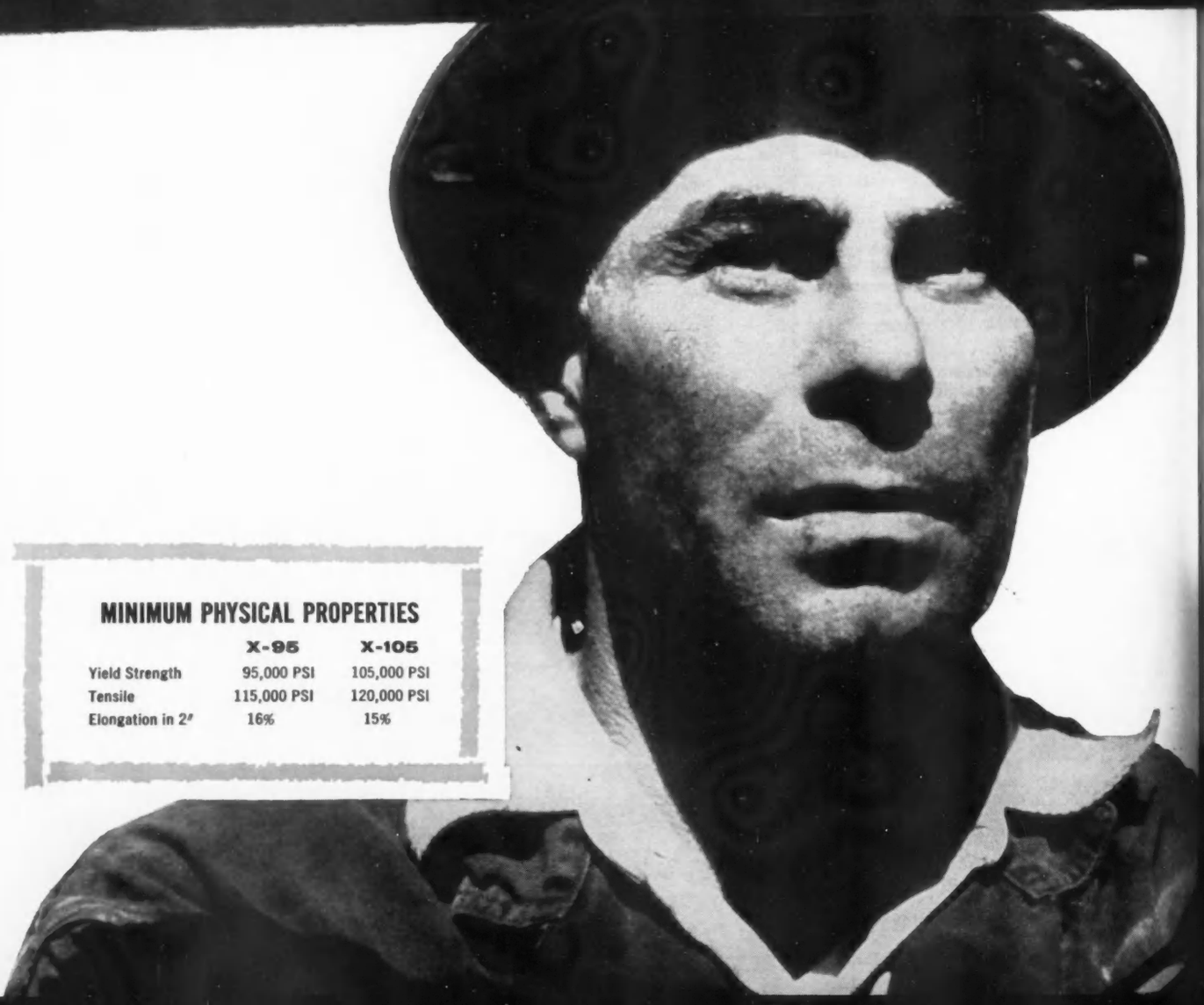

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Yield Strength	95,000 PSI	105,000 PSI
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X-95
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J. E. Despins has been appointed manager, Mexico district, according to an announcement by **Allis-Chalmers de Mexico, S. A., de C.V.** He succeeds **R. B. Rodriguez.**

Canadian Aero Service Ltd., Ottawa, international air survey company, has announced the appointment of **Robert M. Reckeweg** as executive vice president and general manager. He has been associated with the company since it was founded in 1950.

Enardo Manufacturing Company, Tulsa, has appointed four Latin American distributors: **Rodolfo M. Fernandez**, Mexico City; **Kenneth J. Langley**, Bueno Aires; **C. and J. Ormachea, S.A.**, LaPaz, Bolivia; and **Sicol Comercio e Industria**, Rio de Janiero, Brazil.

A. Grey Simpson

A. Grey Simpson has been promoted to the position of California division manager for **Fluid Packed Pump Company.** In his new position, Simpson will direct the Sales and Service operations for the California division. The past two years he has been California sales manager.

Grant Tool Supply has announced the election of **Robert E. Masters** as vice president. Masters is general manager of the **MacClatchie Division.**

Walter E. Munford has been elected president and chief administrative officer of **U.S. Steel Corporation.** Munford succeeds **Clifford F. Hood** who has retired.

Chicago Pneumatic Tool Company Buys Reich Bros. Mfg. Company

The Chicago Pneumatic Tool Company has announced the acquisition of the Reich Bros. Manufacturing Company, Inc., of Terre Haute, Ind., producers of Reich line of truck and crawler-mounted hydraulic rotary blast hole drills and drilling rigs for down-the-hole blast hole operations.

The present personnel of the newly acquired organization, which will be called the REICHdrill Division of the Chicago Pneumatic Tool Company, will continue in their present capacities. Engineering and production operations will remain in the Terre Haute plant and all sales and manufacturing operations in Great Britain will be continued.

Dayton Rubber Company Announce Plans for New Ohio Warehouse

The Dayton Rubber Company has announced the establishment of a new warehouse and regional sales office in Cincinnati. The modern brick and concrete building, currently under construction, is expected to be completed in early July.

Dayton Rubber Company has other warehouse and regional sales offices in Dallas and Atlanta.

The Parkersburg Rig & Reel Co. Establishes Venezuela Subsidiary

The Parkersburg Rig & Reel Company has announced the establishment of a wholly owned subsidiary in Venezuela. The new subsidiary will operate under the name of The Parkersburg Rig & Reel Company de Venezuela, C.A.

Ralph M. Roberts will remain in charge of South American operations with headquarters in Caracas. D. B. Evans will be the Parkersburg representative in Maracaibo, and B. G. McDonald will represent the company in Anaco.

The National Supply Company Acquires Fluid Packed Pump Co.

Acquisition of the Fluid Packed Pump Company, Los Nietos, Calif., has been announced by The National Supply Company.

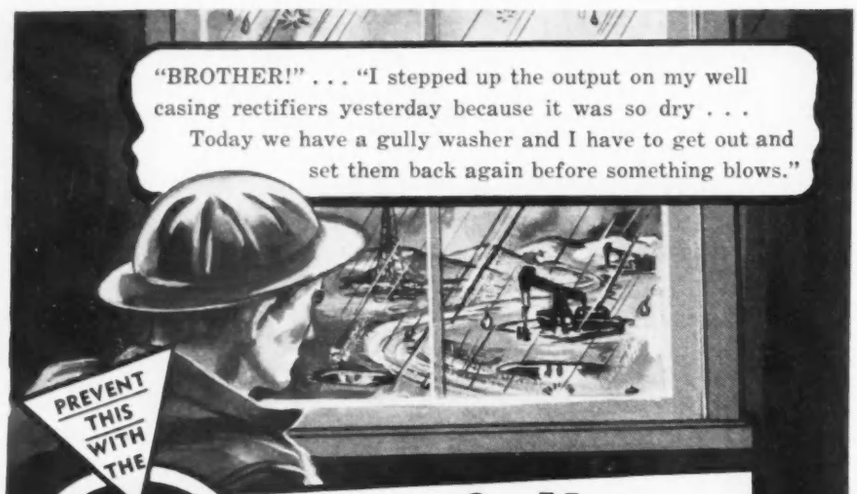
National Supply has been the international distributor for Fluid Packed Pump equipment, with the exception for a few independent outlets, since 1945.

In announcing the acquisition, A. W. McKinney, president, said National Supply would operate Fluid Packed Pump as a division, with Sidney Shuman as chief executive officer.

Lucey Products Corporation Opens New Oklahoma Store

Lucey Products Corporation, Tulsa, has opened a new supply store at Woodward, Okla. The new facility is equipped and carries inventories designed for complete service to the oil operators and drilling contractors that are active in northwestern Oklahoma and the adjoining counties of Texas and Kansas.

The new Woodward store is under the supervision of Clyde E. Richard, store manager. L. W. Johnson, Jr., is assistant manager.


"BROTHER!" . . . "I stepped up the output on my well casing rectifiers yesterday because it was so dry . . . Today we have a gully washer and I have to get out and set them back again before something blows."
PREVENT THIS WITH THE
NEW Good-All
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An entirely NEW CONCEPT in Cathodic Protection.

NEW Any amperage level from rated to minimum can be selected by moving the reactor control handle. No moving parts—no contacts.

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NEW Continuous output adjustment with single control.

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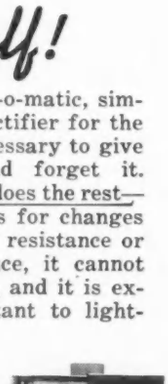

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The Men from "Down Under"

Phil Orr (left) and George Walker (right), Halliburton Oil Well Cementing Co., left for Adalaide, Australia, early this year to open that firm's new "down under" operations. Orr, who will head the new venture, has been with Halliburton since 1949 working in Texas and overseas in Venezuela. Walker is an electrical engineer and has been in Halliburton's export services for 5 years and this is his second assignment in Australia. He transferred to Welex, Inc., in 1958 and will now serve as an electrical service engineer. Halliburton is acting as Welex's overseas agent.

Bovaird Named Distributor for Cardwell Oil Well Parts

The Bovaird Supply Company has announced an important transaction made with Cardwell Manufacturing Company of Wichita, Kan. Bovaird has purchased Cardwell's supplies inventory and Cardwell parts inventory at Oklahoma City, and is moving their Oklahoma City supply store to the present Cardwell location.

Bovaird also purchased Cardwell's oil well supplies and parts stock at Mt. Vernon, Ill., which will be consolidated with the Bovaird store at Salem, Ill. Bovaird will be exclusive distributor of Cardwell parts for well servicing, work over and rotary rigs in both Oklahoma and the Tri-State Area.

Cardwell will continue to manufacture their products in Wichita, Kan.

Lake Shore, Inc. Appointed Bucyrus-Erie Distributor

Lake Shore, Inc., Service and Supply Division, Iron Mountain, Mich., has been appointed an excavator-crane, Hydrocrane, bucket and parts distributor by Bucyrus-Erie Company, South Milwaukee, Wis. Lake Shore's territory includes the Upper Peninsula of Michigan and the northern Wisconsin counties of Ashland, Iron, Vilas, Forest, Florence and Marinette.

Lake Shore, Inc., maintains equipment parts and servicing facilities at its Iron Mountain plant.

Research Exploration, Inc. Opens Alaskan Headquarters

J. F. Freel, president of Research Explorations, Inc., Houston, has announced the opening of headquarters offices for Research Explorations (Alaska), Inc., in Anchorage. Earnest A. Pratt, former geophysical sales manager for Southwestern Industrial Electronics Company, Houston, is general manager.

The new Research Explorations facility includes a complete SIE GeoData Processing System. This will be the only one of its kind in Alaska. The new center will completely process AM and FM tapes from various types of recording equipment.

Officers of Research's Alaskan subsidiary company are Clarence R. Krampitz, president; J. F. Freel, vice president-treasurer; Robert B. Briggs, vice president; David L. Miller, assistant secretary. T. T. Pope, consulting geologist, is a member of the board.

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For more data on advertised products, use Readers' Service Cards, last page.

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Inspection Beginning July 13

OILFIELD EQUIPMENT, PIPE, PUMPS AND OTHER RELATED EQUIPMENT

Due to the dissolution of a partnership, all of the assets of Acord Supply Co., Ltd., will be sold at public auction to the highest bidder. Wayne Cook Associates, Inc. has been commissioned to handle the sale. Items to be offered include Traveling Blocks, Blowout Preventers, Drill Collars, Center Latch, Sidedoor and Bottleneck Elevators, Flanges, Hooks, Kellys, Bushings, Pumps, Rams, Slips, Spiders, Swivels, Valves, Drawworks, Drill Pipe, Casing and Tubing.

EACH AND EVERY ITEM WILL BE SOLD TO THE HIGHEST BIDDER WITHOUT MINIMUM OR RESERVATION

The List Is Far Too Long To Cover Adequately Here But Will Include Such Items As:

1—1953 Willis Jeep
1—1956 Ford ½-Ton Pickup
1—1958 Olds Super 88

PIPE AND CASING

15,000 ft. of 2⅜" EUE Line Pipe Tubing
8,400 ft. of 2⅞" API IF R-2 Drill Pipe
4,500 ft. of 2⅞" Hydril IF R-2 Drill Pipe
3,100 ft. of 3½" API IF R-2 Drill Pipe
3,000 ft. of 4½" Hughes XH R-2 Drill Pipe and more

PUMPS AND MOTORS

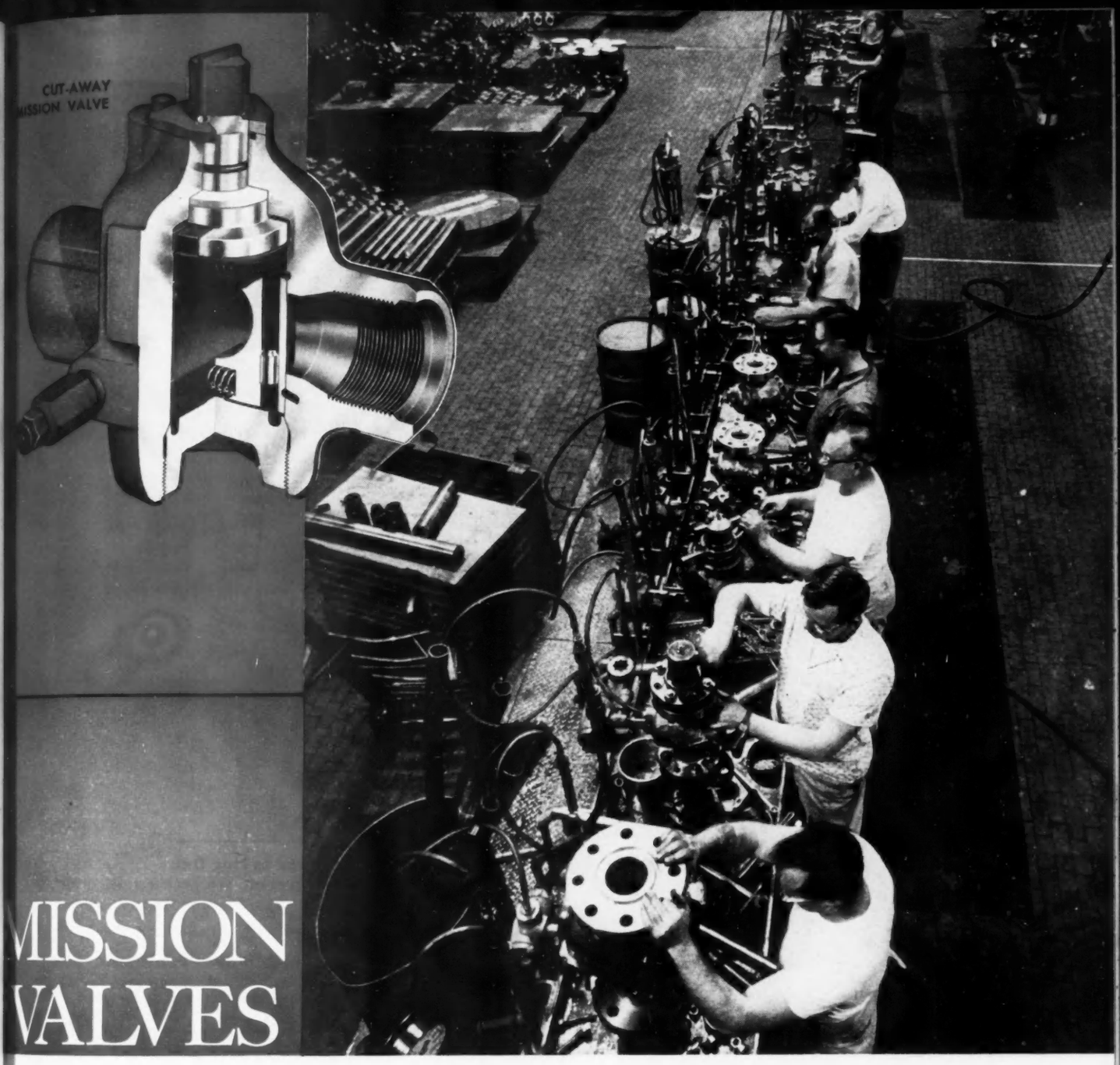
6WAK Waukesha Engine on Skids with clutch and PTO.
International PA 100 Motor on Skids with clutch, V belt pulley and V belts
LeRoi H2000 engine on skids
Worthington Power Pump with Waukesha 195 GK Motor
5 - Gardner-Denver 6 x 6 Steam Pumps
Fairbanks-Morse 4 x 6 Power Pump with Chrysler Ind. Motor
Ideal 6¼ x 10 C 100 Power Pump with Waukesha GK 145 Motor
Gaso Power Pump, 7¼ x 12 Fig. 2652 with 6WAK Waukesha Motor and many others

as well as

Perfection Links, Weldless Bails, Safety Clamps, Drill Collar Slips, 2, 3, 4, 5, and 6 Sheave Traveling Blocks, cap. up to 500 tons; Crown Blocks, various size and make Blowout Preventers with Rams; various size Drill Collars, various size and type Center Latch Elevators, Bottle Neck Elevators, Side Door Elevators; Flanges, Slips, Rotary Tables, Drilling Spools and many other related items. *For brochure with detailed listing of equipment to be sold, contact*

Wayne Cook Associates, Inc.
"The Nation's Leading Auctioneers"

192 Meadows Building Dallas 6, Texas
EMerson 3-3388



MISSION VALVES

protect you with a seal that works for you

Line pressure actually seals Mission Valves more tightly. The greater the pressure against the closed valve, the more tightly Mission Sealant holds—acting like a plastic packing. This automatic sealant injection system literally stops leaks before they start. This basic design, constantly improved upon, has been proved by almost twenty years in the field. Backed up by the modern manufacturing techniques of Mission's new Houston plant, you know you're getting quality. These are the reasons Mission Valves do what they're supposed to do, and do it for years with very little maintenance. There are more than 315 different valves, bringing the positive advantages of the Mission Valve to practically every application. Specify Mission and eliminate your valve problems.

P·E·S·A
PARTNERS IN PETROLEUM PROGRESS

For over thirty years - quality built in to last

MISSION MANUFACTURING CO.

MISSION MANUFACTURING CO., P. O. BOX 4209, HOUSTON, TEXAS • CABLE ADDRESS—"MISSCO"
EXPORT OFFICE: 30 ROCKEFELLER PLAZA, NEW YORK • IN THE UNITED KINGDOM: MISSION MANUFACTURING CO., LTD., 17 HANOVER SQUARE, LONDON W. 1 ENGLAND • CABLE ADDRESS—"MISSOMAN"
PISTONS • PISTON RODS • SLIPS • GLAND PACKINGS • LINERS • LINER PACKING
PUMP VALVES AND SEATS • SWABS • VALVES • HAMMERDRILS • CENTRIFUGAL PUMPS

59-202

WICHTEX
WELL SERVICING UNITS

BUILT TO STAND UP!

Wichtex Units are designed and built to save you repair bills and downtime. Owner after owner has testified that these units "beat anything else in the field" for long, hard service without repairs. Long trouble-free life . . . plus fast, easy, efficient operation . . . make Wichtex Units outstanding profitable to own. Investigate:

WICHTEX WELL SERVICING UNITS
2,000′ to 12,000′ capacity
(spudding attachment optional)

WICHTEX PORTABLE ROTARY RIGS
2,000′ to 5,000′ capacity

WICHTEX
MACHINERY COMPANY
P. O. Box 2250
WICHITA FALLS, TEXAS

SQUEAKS from the BULLWHEEL

"Nice going Mac" WORLD OIL

The Spoils of War

One day during war, a tall, strong and handsome Roman soldier broke into a house where he found two luscious maidens and their matronly nurse.

Chuckling with glee, he roared, "Prepare thyselves for a conquest, my pretties."

The lovely girls fell to their knees and pleaded with him, "Do with us as thou wilt, O Roman, but spare our faithful old nurse."

"Shut your mouth," snapped the nurse, "War is war."

Rising Prices

An aggressive young business man put this sign over a counter in his store, "In keeping with the policies of this store, these FREE SAMPLES are brought to you at the lowest possible price!"

Glarin' and Starin'

The lady was just stepping from the shower, reaching for a towel when she saw a window washer looking in. She was too stunned to move, just stared at the man.

"Whatcha lookin' at lady," he finally asked. "Aincha never seen a window washer before?"

Home Permanent

A neighborhood lady had just given herself a new permanent. Two of her neighbors were discussing the job after she had gone home. "What do you think of it?" asked the first.

"Well, to me," said the second, "it looks like her parole came just as the warden pulled the switch."

Forever in Her Debt

"I married her because she saved my life."

"How did she do that?"

"She told her father not to shoot!"

Absent-Minded Professor

"I am very absent-minded," said the professor. "I often find names and phone numbers written in my memobook, but I can't remember what persons they represent. Recently I did a general checking up. The name and address of one man baffled me, so I wrote him, asked if he had ever heard of me, and if I was supposed to do something for him. He wrote back a cordial letter saying that I had already done it. He was my wife's first husband."

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE & STEPHENS
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

20/20 VISION...

The field of nuclear logging received its greatest advancement when McCullough introduced the Scintillometer back in 1949.

This super-sensitive crystalline detector really gave 20/20 vision to the science of well logging – enabling the operator to see and interpret the nature of the formations surrounding the well bore with greater clarity and in more detail.

McCullough Nuclear Well Logging with the Scintillometer (scintillation spectrometer) has been refined and improved year after year. It is the accepted standard of the industry, giving you more down hole data with greater accuracy – unquestionably the best nuclear logging service available.

★ Scintillometer pin points probable pay zones. Accurately records even minor lithological changes.

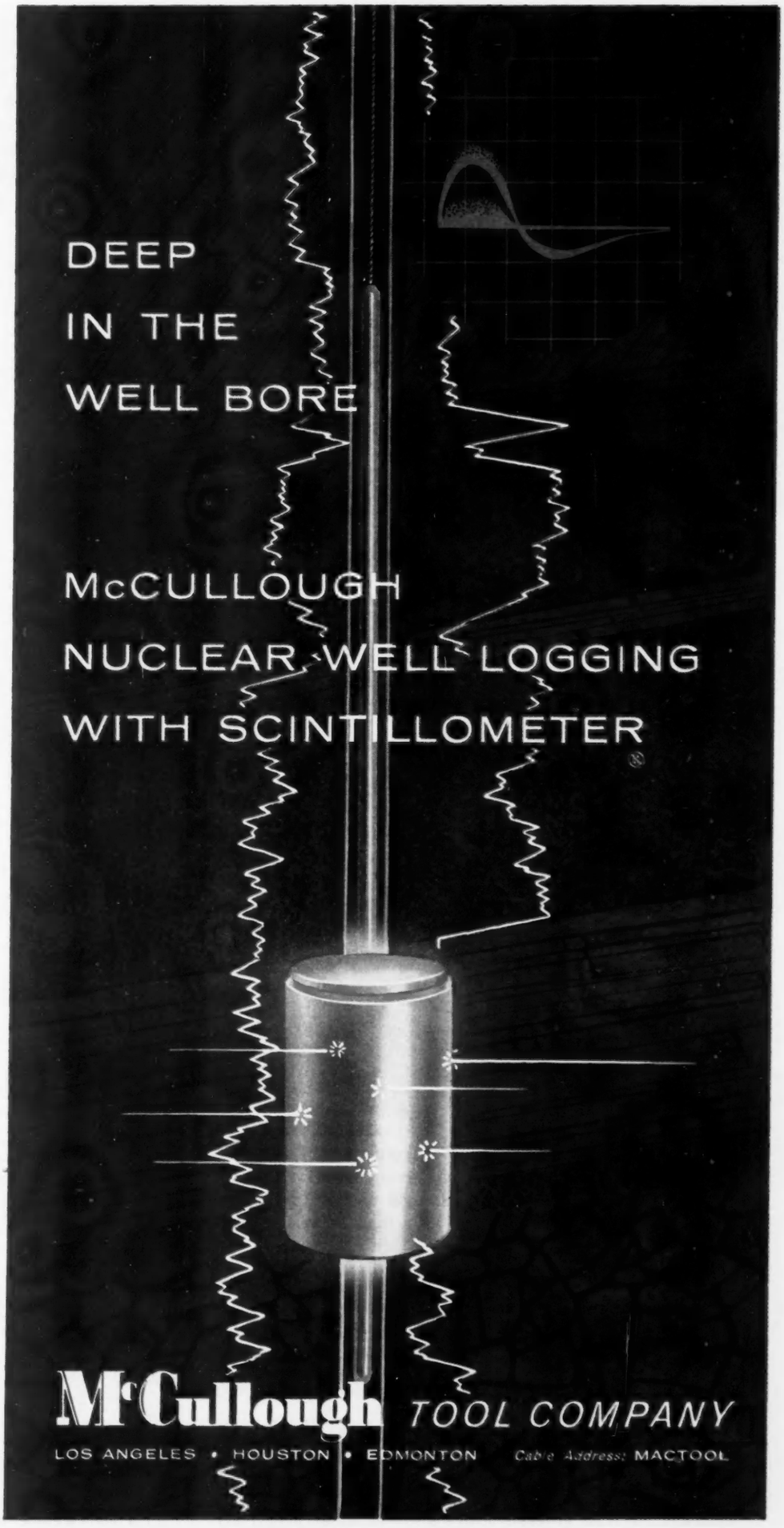
★ Higher counting rate of Scintillometer appreciably reduces statistical fluctuation, gives superior resolution and results in higher quality, more efficient logs with excellent repeatability.

★ Effect of invaded zone and well fluid is minimized and the sphere of investigation is focused on the original nature and content of the formation.

★ Porosity is determined with a higher degree of reliability.

★ Rugged, shock-proof design assures dependable operation.

Call McCullough on your next job – you'll get the best logs you ever had – and you'll benefit by more accumulated experience in nuclear logging with the scintillation crystal than all others combined.



For more data on advertised products, use Readers' Service Cards, last page.

Very Important Person

"I'm sorry, the manager isn't in," said the clerk to the pompous individual who had strutted in. "Is there anything I can do for you?"

"No, snapped the visitor. "I never deal with underlings. "I'll wait until the manager returns."

About an hour later the pompous one became impatient. "How much longer do you suppose the manager will be?" he demanded.

"About two weeks," was the reply. "He just left on his vacation."

A Bargain's a Bargain

Mad wife. "Why did you buy two elephants?"

Inebriated husband: "The man wouldn't break up the pair."

That's What I Like About the South

Old Southern Colonel, discussing food: "All ah want at breakfast is a quart of bourbon, a pound of beefsteak, and my ol' houn' dog."

"What do you need the dog for?"

"He eats the beefsteak."

Frozen Assets

"Sure," admitted the Texan, "with all that ice, Alaska is bigger than Texas. But if Alaska ever had one of our summers, it'd melt to half our size!"

Dining Out

When a restaurant patron complained that his breakfast sausages were peculiar, that there was meat at one end but bread crumbs at the other, the manager explained it was a matter of expediency. "In these times of rising costs, nobody can make both ends meat."

FOR USE IN DRILLING OPERATIONS

Kirkose

SPANS THE WORLD

'KIRKOSE' SODIUM CARBOXYMETHYL CELLULOSE • USED ON A WORLD-WIDE BASIS FOR FLUID LOSS PREVENTION • AVAILABLE IN LOW AND HIGH VISCOSITY GRADES • SALT RESISTANT SUITABLE FOR BRINE MUDS AS WELL AS FRESHWATER MUDS

"In certain Countries of the world the use of S.C.M.C. for drilling operations is covered by patent rights, in connection with which we are empowered to grant licences. In sales for use in these countries (U.S.A., Canada, Mexico, Iran, Colombia, Iraq, Brazil, France) we pay a royalty to Drilling Specialities Company, Bartlesville, Oklahoma, of 7c. per lb. actual S.C.M.C., which is included in our selling price. In consequence, drillers in these countries are licensed to use our product for any drilling operations."

✳CABLE 'KIRKSYL' BURY, ENGLAND. SAMPLES & FULL TECHNICAL LITERATURE WILL BE FLOWN OUT TO YOU ANYWHERE—IMMEDIATELY

Issued by the Chemical Division of KIRKLEES LTD., BURY, ENGLAND

It's Magic

"You say you want to get a divorce on the grounds that your husband is careless about his appearance?"

"Yes, he hasn't showed up in nearly two years."

Optical Illusion

One friend said to another, "Say, how did you get that scar across the bridge of your nose?"

"From glasses."

"Well why don't you get contact lenses?"

"They don't hold enough beer."

Look Alikes

A couple of bebop characters were walking through a Florida swamp. One yelled, "Help, Help! An alligator bit off my leg!"

"Which one? cried his friend.

"I don't know," he answered. "All these alligators look alike."

No Vacancies

"Sorry sir," said the hotel desk clerk to the traveling salesman "but we have no rooms at all. Unless . . ."

"Unless what?"

"Unless you'd be willing to share a room and sleep with a red-headed school teacher."

The salesman drew himself up indignantly and said: "A red-headed school teacher! I know you've heard stories about traveling salesmen, but I'll have you know that I'm a happily married, church-going, home-loving man!"

"Well," said the clerk, "so is he."

He's Got A Secret

The newspaper reporter in an interview with a man who had been celebrating his 100th birthday asked, "And to what do you credit your longevity, Mr. Blackstone?"

The old-timer stared reflectively into space. "I don't exactly know—yet," came the reply, "but I'm dickering with two medicine companies right now."

Spendthrift

"How did George go through his rich uncle's inheritance so fast?"

"Well, he spent a good bit of it on wine, women and song. The rest he squandered."

Our Growin' Children

A first-grader drew a picture of a stagecoach, which was well done except that it lacked wheels.

"Oh, it's wonderful," said the teacher. "But I see no wheels. What holds it up?"

Replied the little artist: "Bandits."

Oops! Wrong Deck

During the war a young pilot landed on an aircraft carrier and hurried to the skipper to say "What a day I've had—I shot down seven Jap planes, sunk a destroyer and left a cruiser listing."

"Velly good, Yank, but you make one mistake!"

The Second Don Juan

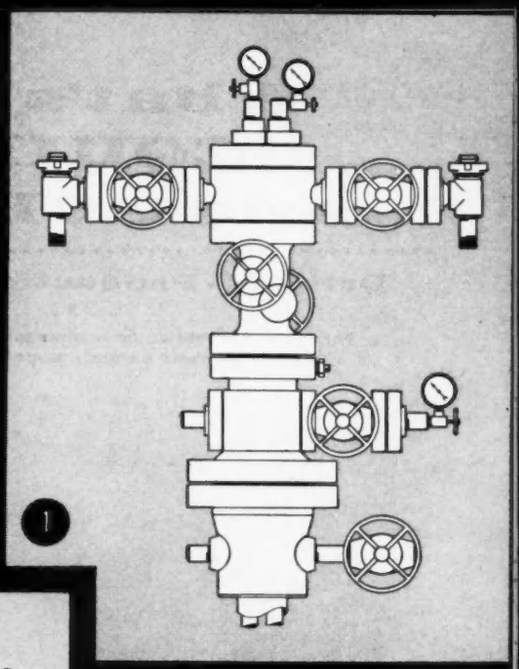
Two truck drivers were waiting for their load and one was very interested in a book he was reading.

The other driver said, "What's the name of the book?"

The reader said, "What Millions of Women Want."

The first one reached for the book. "Let's see if they've spelled my name right."

4 Gulfco Dual String Assemblies

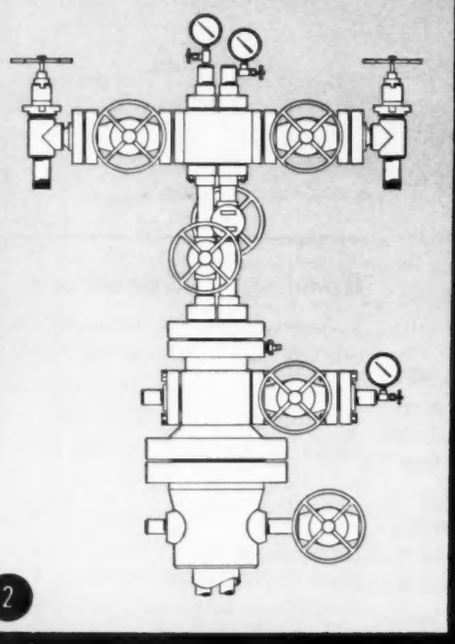


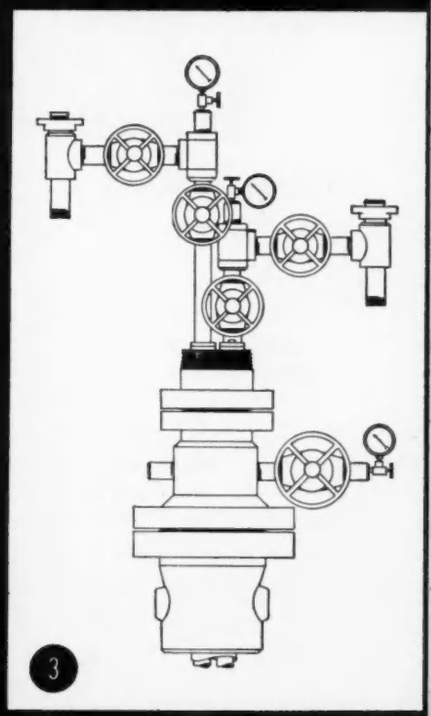
1. Gulfco DMH tubing assembly with separate threaded hangers and integral block master valve. For **highest** pressure and **deepest** wells.

2. Gulfco DMH tubing assembly with individual flanged master valve. For **high** pressure and **deep** wells.

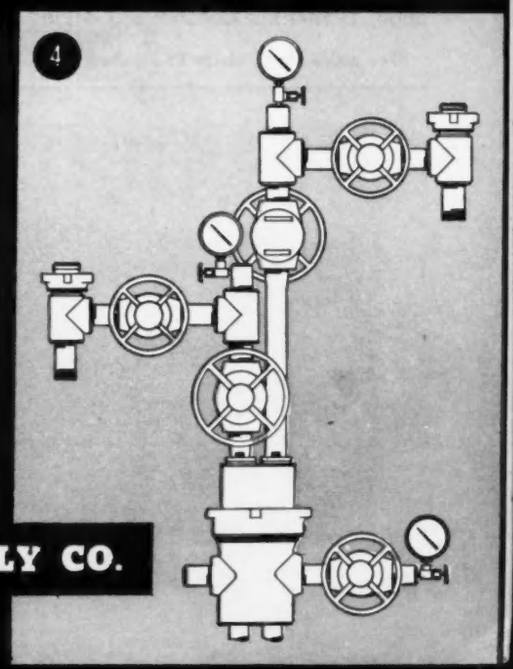
3. Gulfco DCM tubing hanger with individual screwed master valve. (Hangers can be furnished with slips or mandrels.) For **medium** pressure and depth.

4. Gulfco FW-DCM tubing hanger with individual screwed master valve. (Hangers can be furnished with slips or mandrels.) For **medium** pressure and depth.





GULFCO FOR LOW TO HIGH PRESSURES AND SHALLOW TO DEEP WELLS



GET THE COMPLETE STORY TODAY

Whatever your dual completion problem, Gulfco has a tubinghead body and hanger engineered to do the job. You'll get experienced, friendly suggestions when you consult your Gulfco representative. Give him a call today.

Go With GULFCO In '59

GULF COAST MACHINE & SUPPLY CO. GULFCO TRADE MARK PRODUCTS BEAUMONT, TEXAS.

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

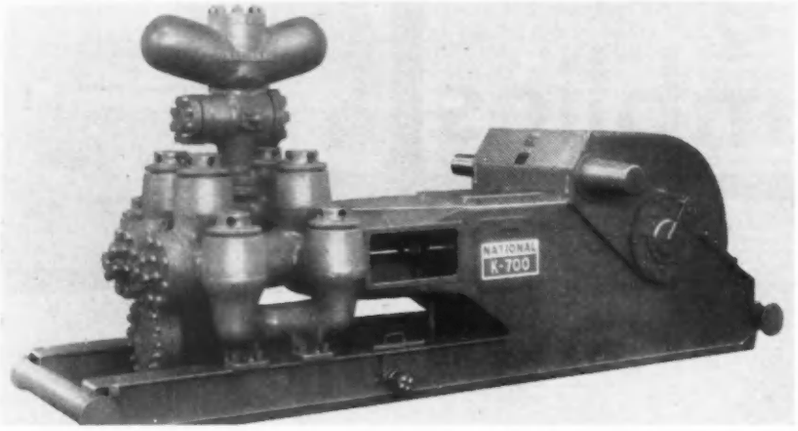
GULF COAST MACHINE & SUPPLY CO.

BEAUMONT, TEXAS

What's New in EQUIPMENT and SERVICES

Drilling - Production - Exploration

For more information on equipment and services described in this issue, circle key numbers on postage-paid postcard and mail to WORLD OIL.



New Slush Pump

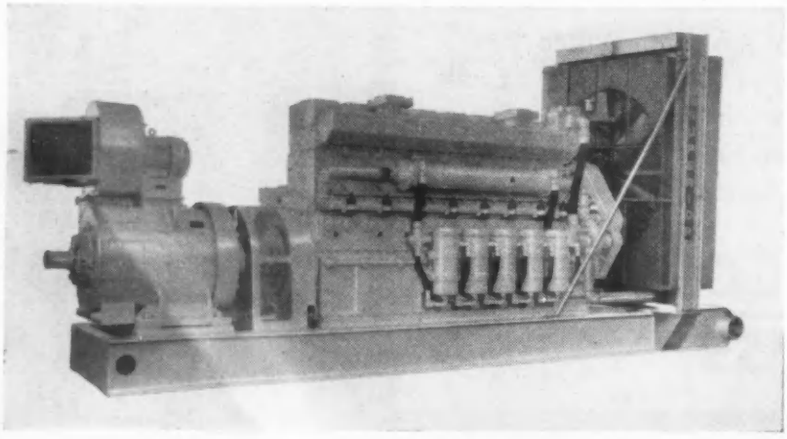
The National K-700 slush pump, rated at 700-input hp, has been announced. With 8-inch bore and 16-inch stroke, the new pump will deliver 845 gpm at 1,205 psi maximum discharge pressure and rated speed of 65 spm. With smallest 5½-inch liner it will deliver 370 gpm at 2,760 psi. The new pump has been made exceptionally light and compact with high structural rigidity by means of a welded assembly of shaped and formed steel plates, structurals and steel castings. Quick accessibility of all parts and ease of removal are features. (The National Supply Co. Supplements data on Pages 3549-3668, 1958-1959 Composite Catalog.)

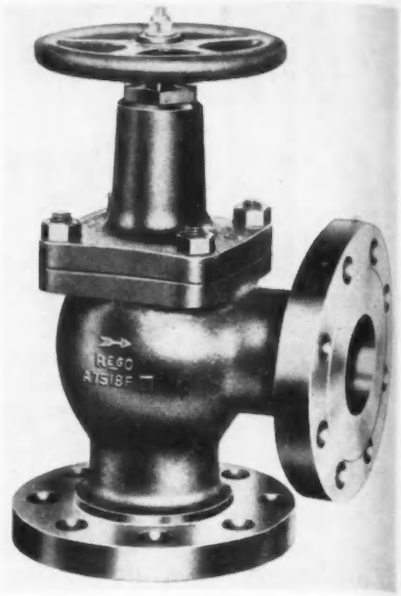
For more data, circle E1 on postcard

Gas-Engine Generator

A new gas-electric power package, one of 263 "drillelectric" combinations developed by the manufacturer, is being marketed. This package produces a continuous rating of 408 kw at 1,020 amps and 400 volts. A simplified electrical system provides individual motor control through compact rectifiers and over-all control through an integrated package that fits into the usual driller's console. Variety of components permits selection of either an electric or electro-mechanical system. (White Diesel Engine Division, The White Motor Co. Supplements data on Pages 5157-5176, 1958-1959 Composite Catalog.)

For more data, circle E2 on postcard





New Flanged Valves

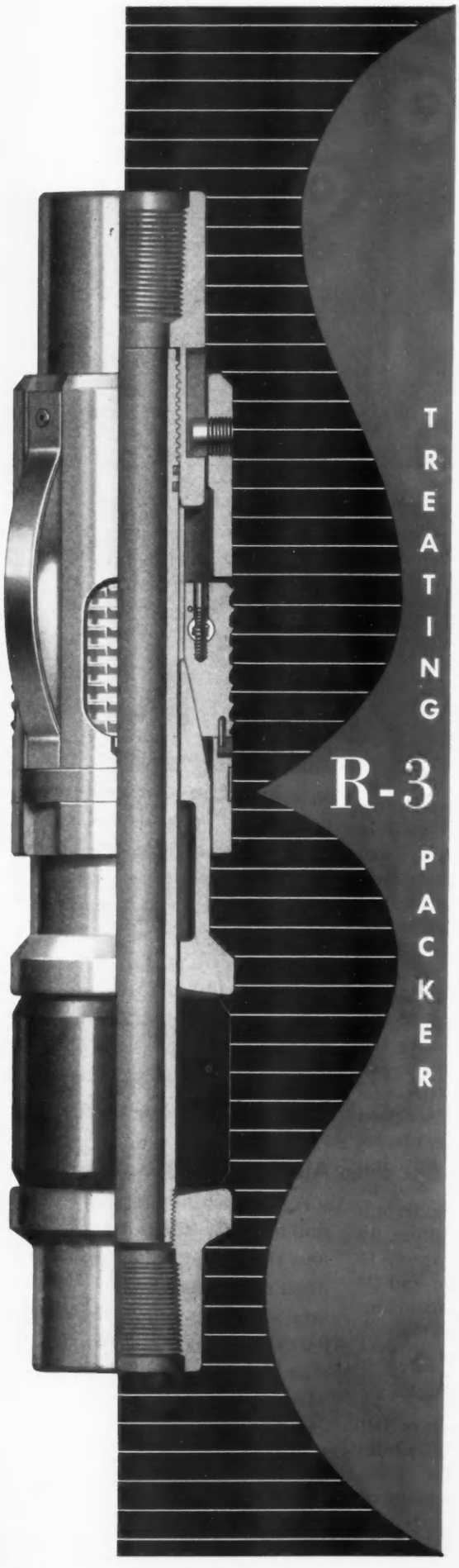
These new ductile iron valves are servicable with such gases as butane, propane, carbon-dioxide, ethylene, natural gas, helium, hydrogen, isobutane, isobutylene, krypton, neon, nitron, propylene and xenon. Features include shatter-proof ductile iron body; rust-resistant stainless steel stem; teflon pressure seal that eliminates stem leakage, resilient synthetic rubber seat to insure positive, shut-off. Flanged dimensions and drillings conform to standard ASA (B16b-1944) class 250. (Rego Division, The Bastian-Blessing Co.)

For more data, circle E3 on postcard

Jar-Keyseat Broach

A new jar-keyseat broach has been put into production. The triple-action tool has been designed to eliminate sticking of drill collars in keyseats, smooth out sharp bends and crooks in holes and remove ledges and shoulder which often cause tools to hang up when coming out of the hole. It is reportedly the only tool available providing a three-way jarring, broaching and reaming action. It can be rented for domestic use, sold for export. (Hunt Tool Co. Supplements data on Pages 2501-2524, 1958-1959 Composite Catalog.)

For more data, circle E4 on postcard



HERE'S THE ANSWER... for shallow well packers!

The new HALLIBURTON R-3 TREATING PACKER for treating, water flooding and producing... can also be used in shallow or low-fluid wells. Short... compact... retrievable ...and dependable, for running on tubing to isolate sections... for *workover and treating* under pressures up to 5000 psi differential. Can be run as tension or compression packer.

The need for tubing hold-down... as in conventional hook wall packers... is eliminated when set in tension since the R-3 *TREATING PACKER* is self-anchoring against pressures from below. When set in compression a hydraulic tubing hold down is used. This arrangement offers the true practical operation for use of this packer at shallow depths.

- Full-opening mandrel permits passage of wire line type tools, instruments or perforating guns.
- Retrievable, may be set and reset on one trip in hole or used from well to well.
- Design makes redressing and replacement of parts a single operation.
- Safety joint allows tubing to be removed. Packer is easily drilled if conditions prevent normal removal.

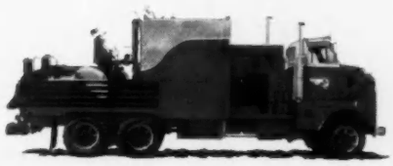
Halliburton Oil Well Cementing Company now proudly adds the R-3 *TREATING PACKER* to its field-tested and proven line of superior quality packers. From the same engineering skills and years of successful experience, that has made Halliburton *foremost in oil well servicing*, comes this newest tool to fill a specific need.

Call your nearby Halliburton Representative for purchase price and full details on the "money-saving" R-3 TREATING PACKER.

HALLIBURTON

CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY
DUNCAN, OKLAHOMA



NO SHUT-DOWNS TO REPLACE EXPENSIVE RUBBER PARTS

PAYNE NON-SEPARATOR TYPE ACCUMULATORS in combination with PAYNE FAST-ACTING AUTOMATIC PUMPS have changed the whole picture of hydraulic power. They offer the most reliable and yet the most economical operation of blowout preventers and pressure operated valves on the market today.

Each 20 gallon accumulator contains a free-moving metal float which takes the place of unreliable rubber goods (bladders and diaphragms). Any volume of fluid is available with multiple units.

Payne Fast-Acting Automatic Pumps keep pressures at the proper level (2,000 psi) and instantly produce additional pressure for emergencies.

Ask anyone who has replaced old-style accumulator units with Payne Non-Separator Type Accumulators — you will understand why the reliability and increased economy of these advanced units have placed them on rigs throughout the drilling areas of the world.

Payne
MANUFACTURING COMPANY INC.
7317-7329 Canal Street HOUSTON, TEXAS
Office WA 8-2626

New Magnetic Tape Playback System

This new magnetic tape playback system is a highly versatile and modern tool which processes either SIE or Techno tapes with a choice of AM or FM recording, high range for static and dynamic corrections, and stacking and compositing with three modes of corrected presentation for better interpretation seismic data. (Empire Geophysical, Inc.)

For more data, circle E5 on postcard

Slim Hole Pump Assembly

This assembly was designed to pump wells which were completed with 2, 2½ or 3-inch casing. The 1-inch pumping string or rod is equipped with specially designed pump through sucker rod joints, alloyed to the pipe with easy flowing, silver type alloy, with ultimate tensile strength of 85,000 psi. This alloy has good corrosion resistance and electrical conductivity for good electrolytic resistance. Material is applied at 900° F., and its content includes 45-50 percent silver, 15 percent copper, 16 percent zinc and 24 percent cadmium. The pump through joint is of C-1213 material and case hardened to R.C. 50-60 to a depth of .010 to maintain flexibility required for effective fluid seal and fatigue resistance. (Jeddy D. Nixon Co.)

For more data, circle E6 on postcard

Portable Rotary Rig

Heavy-duty, lightweight portable rotary drilling rig has conservative capacity of 500 feet using 4½-inch drill pipe. Rig consists of truck, rig frame, rotary table, double drum drawworks, mast, mud pump, separate power unit for drawworks and rotary table, swivel, controls and necessary drives. Transmission is heavy duty with three speeds. (Howard-Turner Machine Works. Supplements data on Pages 2406-2407, 1958-1959 Composite Catalog)

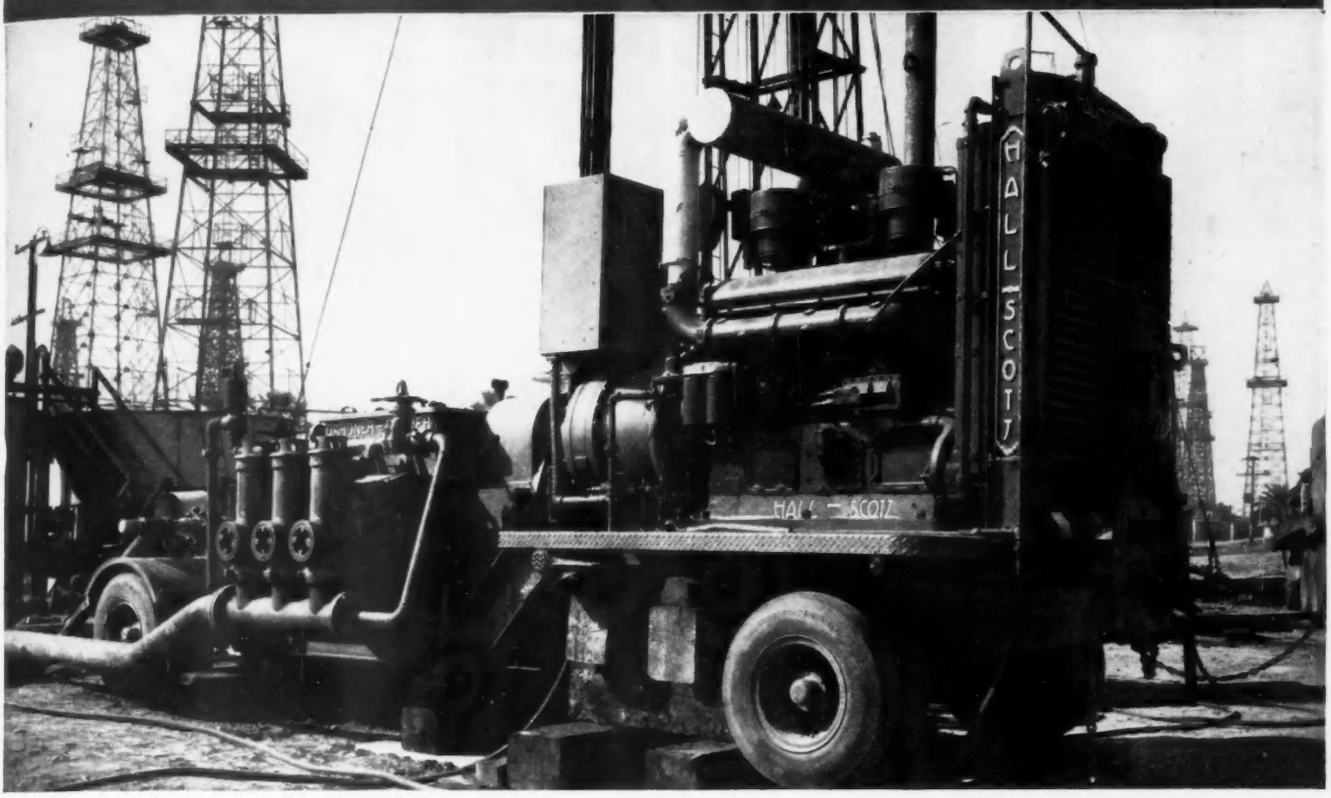
For more data, circle E7 on postcard

All-Purpose Dispersant

A new all-purpose dispersant for drilling muds is called Spersene. Lab tests show new thinner performs well in all muds. Compatability eliminates need of using selected dispersants for particular conditions. Powerful thinning action and low cost is reported. Manufacturer claims costs lower because less needed for viscosity control. (Magnet Cove Barium Corp. Supplements data on Pages 3128-3129, 1958-1959 Composite Catalog).

For more data, circle E8 on postcard

POWER CUTS RIG WEIGHT



HALL-SCOTT MODEL 2269-0 *is ideal for trailer-mounting: weighs only 6700 pounds complete!*

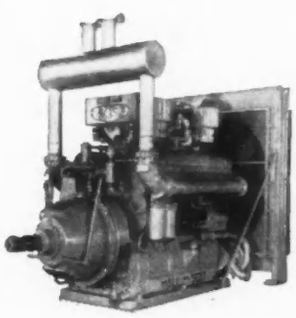
these engines truly portable

Hercules Hall-Scott engines are serving producers the world over . . . have proved their dependability in tough, round-the-clock service.

But the outstanding advantage of the Hall-Scott design lies in its low weight per usable horsepower. The V-12 Model 2269-0, for example, has *less than half* the weight of the nearest comparable drilling engine. Compact, and rated at 500-plus horsepower, four of these engines can be mounted on a single skid! Other Hall-Scott engines offer comparable weight savings over engines in their power range.

As well as the engines shown in these illustrations, Hercules is producing Hall-Scott engines in six cylinder sizes for horizontal installation. Compact in dimensions, these flat engines give a low center-of-gravity to a rig which drillers find valuable in over-the-road transport.

Write your nearest Hercules distributor for further information on Hercules Hall-Scott Series engines. Or write to Hercules, Dept. 22-G, Canton 2, Ohio.



HERCULES
HALL-SCOTT
Model 2269-0
350-575 HP

HERCULES

HERCULES MOTORS CORPORATION
Canton, Ohio

WORLD-WIDE BY HERCULES DISTRIBUTORS

Pan American
Land & Oil
Royalty
Company
has become
Panoil Company

PANOIL

international
petroleum
development

offices will remain at
1130 Republic Bank
Building
Dallas 1, Texas

From the ROYAL FAMILY of
KING SWIVELS
NEW
30, 40 & 50 KG SWIVELS
All with 3" watercourse

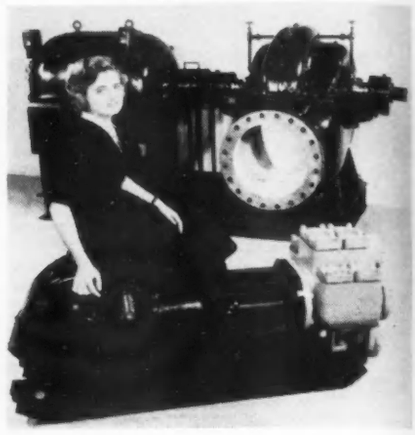
NEW
packing box arrangement eliminates necessity of removing gooseneck and bearing housing to change packing, thus eliminating thread-galling.

SUPERIOR PERFORMANCE
at 100 rpm to 6,200 feet with 2⅞", 3,800 feet with 4½" drill pipe. . . . Perfect for drilling relatively shallow oil wells, the deepest of water wells, workover rigs and slim hole drilling!

NEW!
• Wash-pipe packing box arrangement — interchangeable, all 3 sizes.

• Oversize water course (ideal for conventional and reverse circulation) • Zerk Fitting in stuffing box for simplicity in lubrication of Chevron or V-type packing.

KING OIL TOOLS
P. O. BOX 15146 • HOUSTON 20, TEXAS • OXford 3-3421



New Pumps Introduced

A new reciprocating pump and a new centrifugal pump have been announced by a manufacturer. One of the new models is a 500-hp centrifugal pump capable of delivering 12,000 gpm to a 150-foot head. The other is a 28.5-hp general service reciprocating pump with a capacity of 126 gpm. The latter, designed as a low-priced, standard reciprocating pump for general service, promises to have a wide variety of uses in the oil industry. (Wilson-Snyder Works, Oil Well Suppy Division, U. S. Steel. Supplements data on Pages 3813-3932, 1958-1959 Composite Catalog.)

For more data, circle E9 on postcard

Portable Test Rectifier

A portable test rectifier for determining cathodic protection current requirements to combat electrolytic corrosion is being produced. The rectifier provides adjustable DC output on a timer-interrupted cycle or continuously to determine protective current requirements without unwieldy sources of DC power. Complete unit consists of transformer, selenium air-cooled rectifier, automatic built-in current interrupter, DC ammeter and voltmeter. Weighs only 50 pounds and is encased in heavy-duty steel cabinet. (The Harco Corp.)

For more data, circle E10 on postcard

Seeing is believing . . .

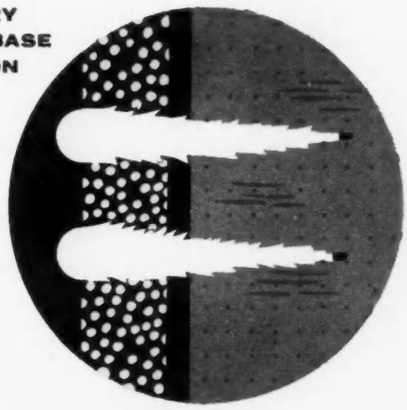
INVERMUL*

BAROID'S *basic additive for* **OIL-BASE-** *emulsion drilling muds*

INVERMUL OIL-BASE EMULSION | ORDINARY WATER-BASE EMULSION

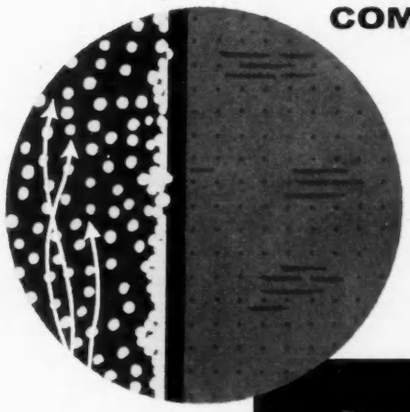
INVERMUL . . . stabilizes oil-base-emulsion mud prepared with crude or refined oils.

INVERMUL MUD . . . protects formations against water damage.



BETTER COMPLETIONS

INVERMUL MUD . . . is easy to maintain or recondition during drilling, coring or working-over.



WATER DAMAGE TO FORMATIONS MINIMIZED

BAROID

BAROID DIVISION NATIONAL LEAD COMPANY

MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

*Trademark of Baroid Division National Lead Co.

5913

Heavy Gage Clamp

A new heavy-gage steel tubing clamp has been designed for faster and better clamping of parallel strings in producing wells. The clamp wraps around all standard tubing and pipe sizes, holding them securely simply by inserting a wedge which is attached to clamp with a breakaway chain. Chain prevents wedge from becoming lost and breaks free if caught or hung. Clamp is case-hardened for durability and cadmium-plated to resist corrosion. (Wedgelock Corp.)

For more data, circle E11 on postcard

JOE STINE

Portable Steel Mud Pits

Safety, economy, and ease in handling drilling mud are major features. They reduce mud losses. Prevent contamination. Permit easier control over weight and viscosity. Provide better and faster means of mixing weighting materials. Standard pits, 6 feet deep, 30 feet long, 7'6" wide. Capacity, approximately 230 barrels. Bottoms of ¼" steel plate; sides, 3/16" or ¼". Heavy reinforcing—3" channel iron ribs on 36" centers—provides strength and rigidity along the sides. Skid-mounted; pits may be hauled on any standard oil field trailer. Special Stine Mud Pits with valves, shale shakers, mud guns, baffles and other features also available.

Write for additional information.

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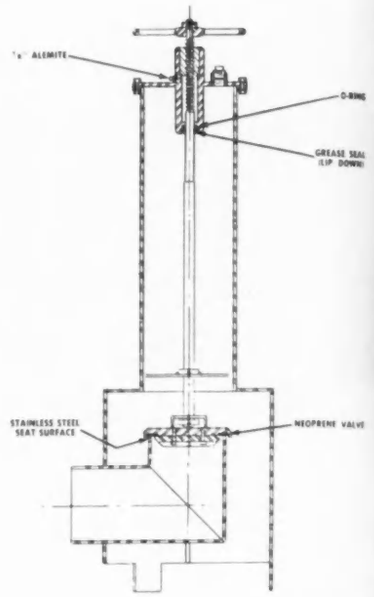


New Mud Valve

A "new concept" in mud suction valves is reported by a manufacturer. Called the T-I-W Model C-847, this mud valve is said to be simple, rugged, dependable and designed for maximum ease of operation, maintenance and repair. The designer says it will not sand up. Entire valve assembly can be removed from its housing for inspection or repair without disturbing the mud system piping or emptying mud pit. (Texas Iron Works. Supplements data on Pages 4833-4866, 1958-1959 Composite Catalog)

For more data, circle E12 on postcard

Nylon Valve and Seat

An improved nylon valve and seat for high-speed reciprocating pumps has been announced. The new valve and seat features a newly designed safety-lock snap ring and new retainer, along with an optional dual spring. The keeper and snap ring arrangement eliminates all threaded connections and simplifies correct assembly of parts. Dual concentric spring enables more spring material to be used in limited space, allowing maximum spring life and more efficient high-speed operation. Nylon is used as the valve member. (Line Scale Co., Inc. Supplements data on Pages 2999-3001, 1958-1959 Composite Catalog.)

For more data, circle E13 on postcard

New Oil Field Truck

A new vehicle called the Sandmaster Oil Field Float is being manufactured for use in countries where dry sand conditions predominate. It basically is one of the manufacturer's heavy-duty export vehicles fitted with sand tires. Special body is electrically welded from the rolled steel main longitudinals to the tool box under front part of body. These heavy-duty vehicles have wide range of use. Turbocharged 6-cylinder oil engine develops 200 bhp at 1,700 rpm, and a maximum of 625 lb./ft. torque at 1,000 rpm. (Transport Equipment [Thornycroft] Limited.)

For more data, circle E14 on postcard

New Pipe-Coupling

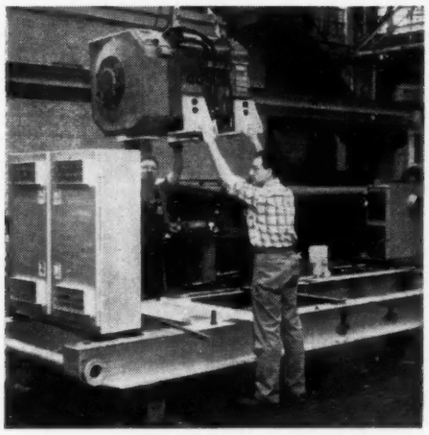
Designed to fill the need for a universal type of coupling, this new pipe coupling will connect plain-ended pipes, threaded pipes, pipes bevelled for welding and pipes grooved to take various forms of other pipe couplings. It can be used on thin wall or standard pipe and will couple plain-ended pipe having the normal commercial O.D. tolerance. It also will couple pipes already screwed. It is called the Seamark "Versatile" Pipe-Coupling. (Wilson Pipe Fittings Limited.)

For more data, circle E15 on postcard

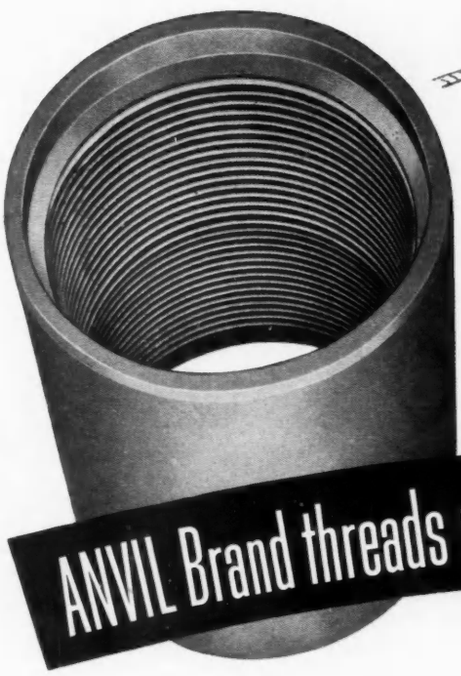
New Power Package

A simplified diesel-electric power package for medium depth drilling and workover rigs has been announced. It's a complete electric drive system matched with a 500-hp twin diesel engine for smaller rigs. Electric transmission and control equipment is adaptable to natural gas engines. Simplicity is the dominant factor of the new unit, called the SR-5, resulting in faster rig-up, unlimited rig arrangement, ease of control, low maintenance. (Electro-Motive Division, General Motors.)

For more data, circle E16 on postcard



When you're making string



ANVIL Brand threads make it faster!

ANVIL Brand threads are clean, accurately tapered, and electro-galvanized; chamfers and recesses are precision machined. The result is a coupling that makes up fast and firm, without galling.

When you're making string—or pulling it—Anvil Brand Couplings give you the trouble-free service that helps you get lower costs on drilling and production.

Anvil Brand Fittings—A.P.I. Couplings for all oil field uses, as well as bushings, plugs, and nipples, are sold through your nearest supply store. Engineering service is always available from Anvil Brand Representatives in key oil country locations. Write today for information.

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forged seamless and wrought steel pipe fittings

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describes Bethlehem's three-step procedure in the complete planning and construction of secondary-recovery projects. It surveys the general mechanical requirements of the typical waterflood project, and discusses the machinery and equipment necessary to the successful procurement of raw water, its treatment, distribution, metering, and injection. For your copy, use the coupon.

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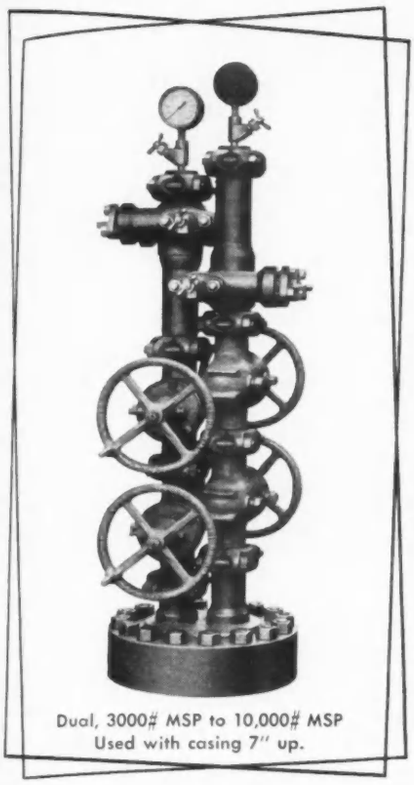

Dual, 3000# MSP to 10,000# MSP
Used with casing 7" up.

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Engineered Well Control For Complete Safety

Basic, good engineering design — an extra value built into every Gray Well Control Assembly — demands more strength with less weight, reduction of areas subject to pressure, and elimination of unnecessary parts. An added feature in Gray's Systems is flexibility. Flexibility provides for efficient handling of every well control problem through the application of practical design techniques.

Gray Well Control Systems are engineered to meet the most exacting specification requirements coupled with flexibility. The result is practical, economical well control safety at whatever pay zone you're working — deep or shallow, single or multiple.

For additional information about why engineering makes Gray's Systems best for complete well control, see the Gray Catalog in Composite Catalog or write Gray Tool Company. Remember, Gray gives complete well control for complete safety and . . .

Safety is Economy

GRAY *Tool Company*

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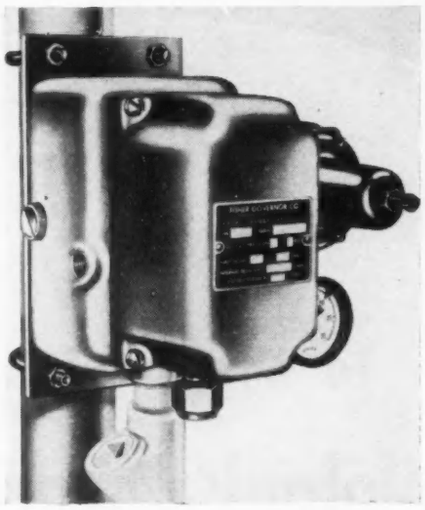

New Electric Transducer

This transducer uses a high-capacity relay to produce a pneumatic output pressure that is proportional to a dc milliampere input signal. Allows the use of fast electrical transmission in conjunction with dependable and inexpensive pneumatic valve actuators. Balanced to operate in any position without zero shift and flexure strips are used to give frictionless pivots. (Fisher Governor Co. Supplements data on Pages 1752-1760, 1958-1959 Composite Catalog)

For more data, circle E17 on postcard

Simplex Print Recorder

This new unit provides a method of recording complete, comprehensive automatic well testing and producing information. It records, prints well identification, date, time and test data. All models can have 1, 2, 3, or 4-data channels, as desired, and station identification of up to four digits can be incorporated. (Garrett Oil Tools, Inc. Supplements data on Pages 1919-1923, 1958-1959 Composite Catalog)

For more data, circle E18 on postcard

use

EXTRA STRENGTH

for dual completion oil wells

These couplings have thinner walls and a special O.D. chamfer to accommodate two lines in one casing. Due to the thinner wall we recommend:

N-80 COUPLING FOR USE WITH J-55 TUBING
Identified by all-over red for N-80 and green stripe for use with J-55 tubing.

P-105 COUPLING FOR USE WITH N-80 TUBING
Identified by all-over white for P-105 and red stripe for use with N-80 tubing.

PACKED 25 PER CARTON

Order all your fittings from

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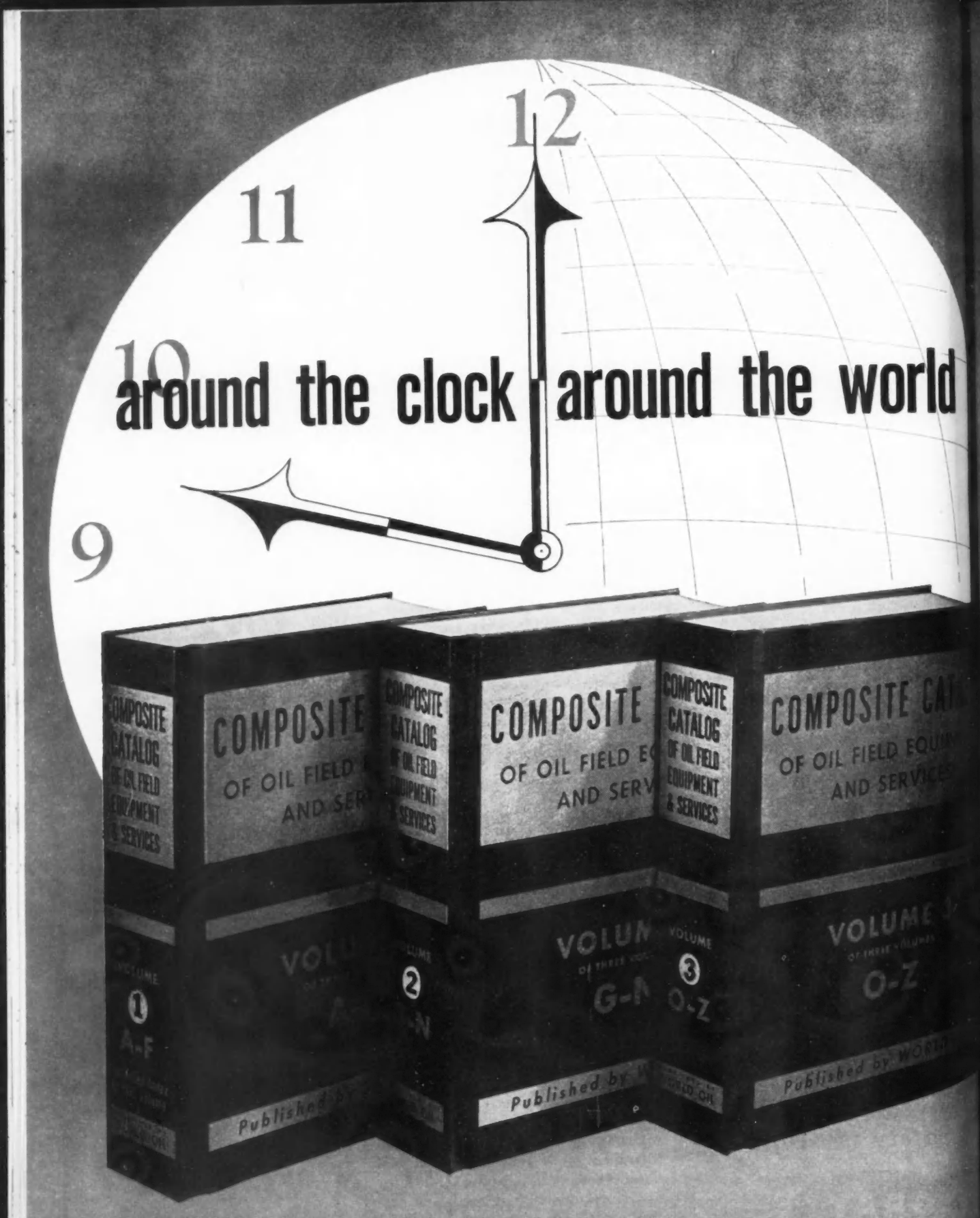
For more data on advertised products, use Readers' Service Cards, last page.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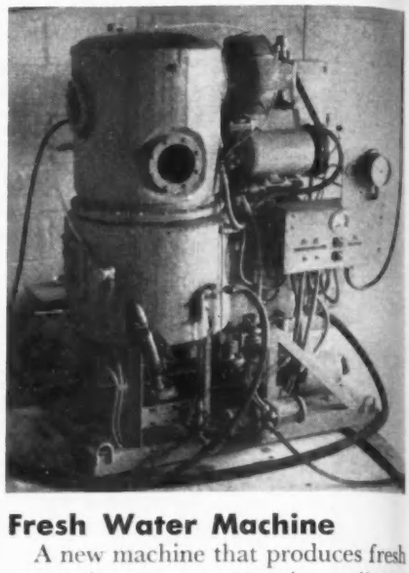

Fresh Water Machine

A new machine that produces fresh water from sea water is available. Scaling problem has been eliminated (without any acid feed), efficiency greatly increased (less fuel required), assured low maintenance by mechanical simplicity and low corrosion rates (due to low temperature operation). Machine operates continuously at peak output and peak efficiency. (Mechanical Equipment Co. Supplements data on Pages 3389, 1958-1959 Composite Catalog)

For more data, circle E19 on postcard

Drill String Stabilizer

A new replaceable welded blade stabilizer, designed for efficient use in any oil field, is being manufactured. Welded, drillable blades are cast on a helix to fit contour of the bore hole to allow smooth, torque-free rotation of the string while preventing downhole whip of pipe and collars. Maintenance is reduced to a minimum. Solidly welded blades cannot come off in hole. Any competent welder can change the blades. Blades are hardfaced with a tungsten carbide material at factory. (A-Z International Tool Co.)

For more data, circle E20 on postcard

Gravity Meter

This meter, the Master class, has unique low power, temperature-stabilizing feature included to obtain greater linearity for all gravity readings, regardless of the range and severity of temperature fluctuations. Greater accuracy means absolute minimum number of base ties are required during field surveys. Also includes more demanding specifications than previous models, such as increased small dial range and full 90 latitude temperature compensation. Master meter class increases accuracy and keeps reliability. (Texas Instruments Inc.)

For more data, circle E21 on postcard

New Slip Bowl

A newly designed, heavier-bodied slip bowl is available for all models of Kel-Co power slips. In burst tests, the new bowl held twice the weight under which 7-inch casing will part, according to the manufacturer. Other tests showed safety factors up to ten times parting weight of 4½-inch drill pipe. (Ben F. Kelley Co., Inc. Supplements data on Pages 2815-2826, 1958-1959 Composite Catalog)

For more data, circle E22 on postcard

HYCALOG

NEW WELL LOGGING PACKAGE CUTS COSTS... PROVIDES EXTRA INFORMATION

CONTINUING RESEARCH FOR LOWER COST EXPLORATION

Continuous chromatographic monitoring and analysis of gas shows . . . *along with recording of principal drilling functions* . . . are combined in Hycalog's new GR-FDR package. And automatic operation permits the use of this equipment with *only one* attendant.

The package includes *two complete recording networks* . . . HYCALOG GAS CHRONOFRAC and a hot wire detector. One monitors methane content of mud gas samples and analyzes shows; the other records total combustible gases.

Added to this is the MARTIN-DECKER recording network which automatically measures and records the following drilling functions: weight on bit, pit level, pump pressure, and pump speed. (Recording of other functions such as torque and rotary speed are optional).

A *single* operator compiles and forwards daily all recorded data along with the log of any shows encountered.

With the new GR-FDR package you are sure of getting *round-the-clock* information at a cost far below regular well logging service.

Write for facts on the GR-FDR package. *And, while you're at it, ask about* HYCALOG V-DOOR *diamond drill bits.*

Hycalog, Inc.

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SHREVEPORT, LOUISIANA

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DIAMOND CORING • DIAMOND BITS • WELL LOGGING • CORE ANALYSIS

MAKE YOUR WELLS WORTH MORE

Let Dowell Engineer Your Frac Jobs With "Frac Guide"

Now operators are getting far better results and a much higher percentage of successful fracture treatments than they were only six months ago. These results include faster payout, lower lifting costs, higher production increases and better decline curves. Perhaps you can benefit, too. Ask your Dowell representative to use the "Frac Guide*" to design the most profitable treatment for your well.

What The "Frac Guide" Can Do For You

The Dowell engineer will want to take into consideration as many of these factors as possible:

- Depth, thickness, permeability and porosity of producing zone
- Viscosity, gravity and compressibility of reservoir fluid
- Reservoir pressure and bottom-hole temperature
- Previous treatment data — pressures, injection rates and materials.

Then, using the charts and formulas in his manual, he can predict — with reasonable accuracy — the effect of these variables:

- Volume of fluid; amount of sand
- Type of fracturing fluid
- Injection rate
- Addition agents
- Multi-stage treatments.

From these calculations he can engineer the most economical treatment — to help you get the results you want at the greatest net profit to you.

Since he can predict treatment results with greater accuracy, failures with consequent loss of production have been greatly reduced.

Since he can determine the fluid loss of various fracturing fluids, he can select the lowest cost fluid to give the desired fracture area.

Since he can predict the fracture volume with improved accuracy, he can more accurately calculate the amount of sand required to give a fully packed fracture. This reduces the healing of fractures and maintains large flow channels for profitable production, slower decline rates and maximum recovery.

Since he can predict injection rates and pressures, he can use high sand concentrations with less danger of unplanned sandouts. This helps keep down both fluid and pumping costs.

Just How Good Is The "Frac Guide"

Dowell engineers gave the "Frac Guide" a number of tests before releasing it for general use:

First, they used it to predict treatment results on hundreds of wells. Then, they compared these predicted results with known results of frac jobs already made on the wells. *They discovered that predictions made with the "Frac Guide" closely corresponded with what actually did happen.* More important, they also found many instances where they could have engineered a far more profitable treatment if the "Frac Guide" had been available.

Second, they started designing new treatments using the "Frac Guide." *The success ratio jumped from less than 60 to 97 per cent on the first 300 jobs.* Results were also far better than from previous treatments on similar wells.

Really engineered fracturing with the "Frac Guide" was pioneered by Dowell, so Dowell has the greatest backlog of experience in the industry. Call your nearest Dowell engineer for more information. Get him to *engineer* the treatment for your next well. There is no additional cost. Dowell has more than 165 offices and stations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

Services for the oil industry

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

Here are examples of the type of results that are being

In the Texas and Oklahoma Panhandles —

—16 treatments were engineered with the "Frac Guide." These treatments produced production increases that averaged 63 per cent better than those obtained by previous treatments on similar wells. In many wells, treatment costs with the "Frac Guide" averaged 20 to 30 per cent less than costs on previous treatments. The improved production increases meant faster payouts and more profitable wells.

In the Denver Julesburg Basin —

—treatments engineered with the "Frac Guide" have been used in both the "D" and "J" sands. Generally, payout time on these jobs has been about half that of previous treatments because the desired amount of sand can be put away with less refined oil. For example, two treatments into the "J" sand were compared. Payout time for the job using the "Frac Guide" was only 100 days as compared to 186 days for the other job. In another study of two treatments, the cost of the job using the "Frac Guide" was about $2000 less, and payout time was more than 50 per cent less.

In Northern Oklahoma —

—40 wells treated with the "Frac Guide" were compared with other fractured wells. The jobs using the "Frac Guide" cost about 15 per cent more but allowed the use of 50 per cent more sand. Initial potentials of the wells treated with the "Frac Guide" were higher, and decline curves are expected to be flatter.

In Southern Oklahoma —

—the "Frac Guide" has permitted the use of water-base fluids instead of more expensive fracturing fluids. Many wells have been treated with four-cent-per-gallon fluids instead of the 10-cent-per-gallon fluids previously used. Many excellent producers have resulted.

In Lea County, New Mexico —

—Lea County wells treated with and without the "Frac Guide" were compared. The wells for which treatments were engineered with the "Frac Guide" averaged 295 bopd flowing, while other fractured wells averaged less than 70 bopd pumping.

Early dawn in the Four Corners area finds operators and Dowell ready to go. Dowell fracturing treatments in formations like the Gallup have been particularly successful.

obtained with the help of "Frac Guide" developed by Dowell

In Crane County, West Texas —

—wells completed in the San Andres have shown much slower decline rates after treatments with the "Frac Guide," even though there were no significant increases in potential.

In Ector County, West Texas —

—a comparison of wells in the Edwards pool was made. Treatments engineered with the "Frac Guide" gave production increases about 40 per cent greater than other treatments in the same field.

In the East Texas-Northern Louisiana area —

—comparisons were made on a control group of eight wells—four wells were treated with the "Frac Guide," and four without. All wells were completed into the Mooringsport formation and were generally similar. Treatment costs for the wells fractured without the "Frac Guide" averaged $4440; and average production test figures rose from 6.5 to 55.5 bopd. When the "Frac Guide" was used, treatment costs dropped to an average of $2904. Average production test figures rose from 8 to 121 bopd. In this case, an average of $1536 was saved per treatment, and results were greatly improved.

In Uintah County, Utah —

—a well was producing 10 bopd and failed to respond to a fracturing treatment. Another similar well was treated with the aid of the "Frac Guide." This well was also producing 10 bopd before treatment. After fracturing, production shot up to 220 bopd; and the well was still producing 185 bopd—steady—60 days later.

In Converse County, Wyoming —

—two treatments made with the "Frac Guide" were compared with other frac jobs made on the same lease. Previously, rapid production declines to 12 or 15 bopd had made frequent re-treatments necessary. All wells in the field had been pumping. Though the jobs with "Frac Guide" cost about twice as much, production stabilized at about 56 bopd *flowing*, lifting costs were reduced and payout was faster.

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More Magnetic Fishing Jobs Successfully Completed With K & G Tools and Methods than with all other magnetic tools combined...

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K & G MAGNETIC FISHING TOOLS
DRILL PIPE JUNK SHOT
ADJUSTABLE CORE BARREL MAGNET

Available in popular sizes from most major fishing tool companies. Be sure to see that it's K & G . . . the only company licensed to manufacture under U. S. Patent No. 2,668,077.

Call, write or wire for quotations on use in your area.

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Literature

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Prefabricated Buildings

A 28-page brochure is available from Crosley Buildings, Limited, giving detailed information on the company's complete line of prefabricated steel buildings. Brochure gives engineering data and specifications including detailed drawings and installation data.

For more data, circle E23 on postcard

New Film Available

Fisher Governor Co. has released a 16 mm color film on fluid control equipment. Films show in pictorial style how control valves function and how they are engineered.

For more data, circle E24 on postcard

Marine Power Booklet

The Engine Division of Caterpillar Tractor Co. has compiled a booklet entitled "Power at the Wheel" for oil men who operate workboats, self-propelled barges and towboats in offshore operations. Booklet describes use of Caterpillar diesels for original, replacement and auxiliary power.

For more data, circle E25 on postcard

Cable Tool Catalog

Rampp Co. has announced publication of a new catalog of cable tools. The new catalog features all regular drilling tools, fishing tools and casing tools plus many specialties.

For more data, circle E26 on postcard

Sucker Rods

The National Supply Co. has issued a revised bulletin covering five grades of sucker rods, including the new top tensile strength Grade 85 (113,000 psi), which was not in the 1956 Bulletin.

For more data, circle E27 on postcard

Drilling Control System

General Electric presents detailed information and technical data on its control system and components for electric drive for oil well drilling in a new bulletin, GEA-6894.

For more data, circle E28 on postcard

Sizing Separators

A new method of sizing oil and gas separators for a wide range of well stream conditions is available in a booklet published by Black, Sivalls & Bryson, Inc.

For more data, circle E29 on postcard

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

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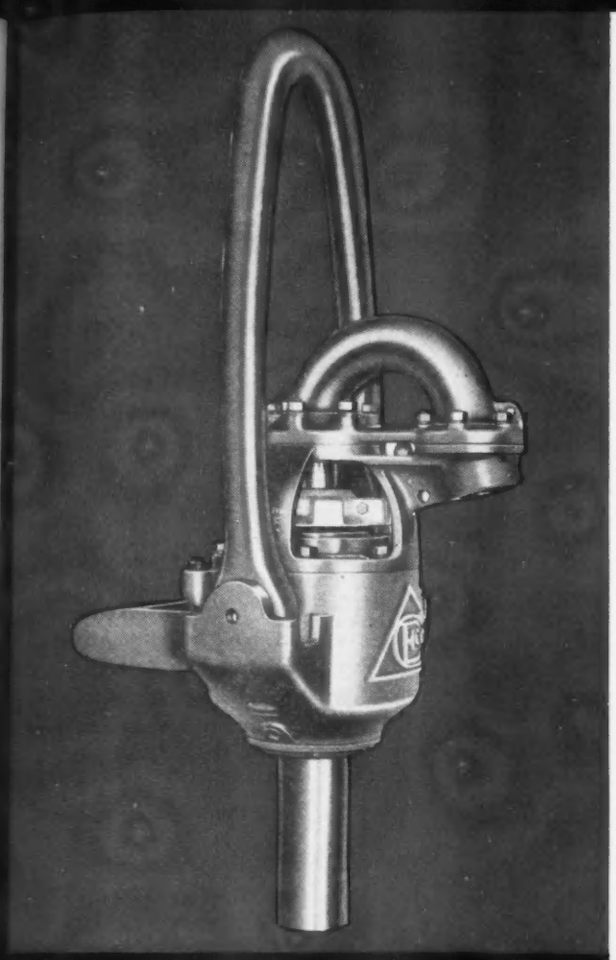

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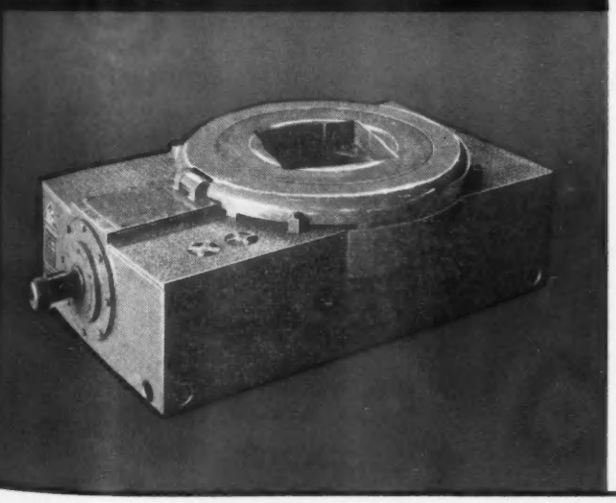

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at LESS cost

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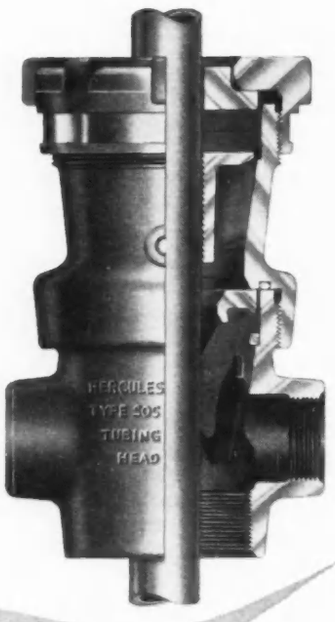
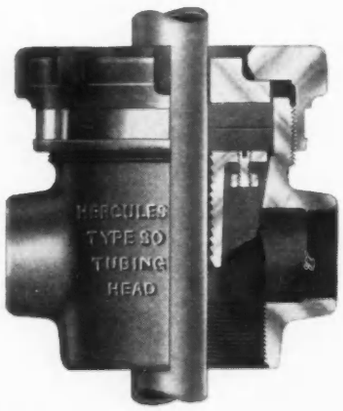
TUBING HEAD

Hercules "Type SOS" is a 4000 pound test stripper tubing head. The lower section contains the neoprene tubing stripper; the upper section or bowl contains the slips and packing arrangement. The SOS is unsurpassed for use in well servicing operations in addition to its use in flowing wells.



HERCULES TYPE SO
TUBING HEAD

Hercules "Type SO" tubing head is actually the lower section of the "Type SOS" tubing head, containing the slips and packing arrangement. It is particularly suitable for pumping due to its compactness, being approximately 12 inches high.



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New Packer Retriever

A brochure from Bowen Itco, Inc., describes a new packer retriever. Folder covers use, advantages, operations, instructions, specifications of sizes, as well as optional equipment.

For more data, circle E30 on postcard

Torque Converter Bulletin

National torque converters for heavy industrial applications is the subject of The National Supply Co. Bulletin 496. Twelve-page bulletin covers general advantages of torque converters and special features of National equipment.

For more data, circle E31 on postcard

Electric Drive Booklet

More profitable operations through faster, more efficient drilling and other cost saving advantages of electric drive are explained in full-color bulletin (GEA-6872) from General Electric Co.

For more data, circle E32 on postcard

New Bit Catalog

A new catalog describing full line of Blue Demon replaceable blade all-formation drill bits has been published by Herb J. Hawthorne, Inc. Part numbers, descriptive nomenclature, shipping weights and prices are included. All common thread connections are identified.

For more data, circle E33 on postcard

Capacitors Described

New General Electric Co. bulletin (GEA-6625) describes pump-motor capacitors, 2 to 15 KCAR, 460 volts, and application to oil field systems. Operational charts and tables of recommended ratings included.

For more data, circle E34 on postcard

New Drilling Rig

Complete information on the National T-45 drilling rig, designed for the 4,500-7,500 foot range, is available in a new bulletin from The National Supply Co. Performance chart, possible drive groups, dimensional drawings, and specifications are given.

For more data, circle E35 on postcard

Drilling Clays

A new concept in drilling muds is advanced in a bulletin from Minerals & Chemicals Corp. of America. Booklet presents case for Attapulgus clay as a component for drilling muds in contaminated fresh water as well as salt water systems.

For more data, circle E36 on postcard

DIRECTIONAL DRILLING · FISHING & CUTTING · ELECTRICAL WELL SERVICES · OILFIELD SUPPLIES · EXPORT TOOLS & SERVICE

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Stops the trouble before it starts

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WRITE FOR TECHNICAL INFORMATION AND BROCHURES

New Fracture Method

A new planning method for fracturing jobs is being made available by Halliburton Oil Well Cementing Co. The method is described as a simplified approach to a complex problem and an important step toward obtaining optimum fracture treatment of a particular well, or an entire field.

For more data, circle E37 on postcard

New Aluminum Pipe

Reynolds H-E pipe, the new thick-jointed aluminum pipe originated by Reynolds Metals Co., is described in a new brochure. The pipe is now available in a complete range of Schedule 40 equivalent sizes.

For more data, circle E38 on postcard

Magnetic Tape Bulletin

Methods of reducing signal drop-outs in magnetic tape are discussed in a bulletin available from Minnesota Mining and Manufacturing Co. Bulletin is illustrated with photomicrographs of common types of coated-in tape flaws and other photographs.

For more data, circle E39 on postcard

Rigid Plastic Pipe

A new bulletin from Marbon Chemical Division, Borg-Warner, is designed to provide basic performance and installation facts on rigid pipe af ABS plastic.

For more data, circle E40 on postcard

Special Tools

A brochure illustrating the complete line of specialty tools and products manufactured by Pathfinder Oil Tool Co., is available. A centralizer specially designed for various operating conditions is illustrated. A well bore wiper, stop collar, special no-weld compound, and a lost circulation additive are also covered.

For more data, circle E41 on postcard

Liquid Level Control

Information on how to provide operating and safety controls for a wide variety of jobs involving liquid level and liquid flow is contained in a new bulletin (ERS-A) published by McDonnel & Miller, Inc.

For more data, circle E42 on postcard

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